This 1983 Proceedings of the U.S.A.H.A. is dedicated to the memory of Dr. W. E. Lyle, Madison, Wisconsin.

Dr. Lyle served the U.S.A.H.A. and the A.A.V.L.D. in leadership roles for many years as a member and chairman of committees. He was a moving force on the Brucellosis Committee in trying to get the disease eradicated and represented his respective state on the Executive Committee of U.S.A.H.A.

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<thead>
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<th>Member</th>
<th>City, State</th>
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<tr>
<td>D. A. Armstrong, Lincoln, NE</td>
<td>D. A. Gable, Fairfax, VA</td>
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<td>D. T. Bechtol, Canyon, TX</td>
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<td>D. L. Wilkes, Englewood, CO</td>
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Chairman: R. A. Bankowski, Davis, CA
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<th>Member</th>
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<td>W. W. Adams, Gainesville, GA</td>
<td>Marshal Meyers, Washington, DC</td>
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<td>T. B. Angel, Jr., Florence, KY</td>
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<td>W. T. Tramel, Mississippi State, MS</td>
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<td>C. R. Weston, Walpole, NH</td>
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J. C. SHOOK
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<tr>
<th>Date</th>
<th>Place of Meeting</th>
<th>President</th>
<th>Secretary</th>
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<tr>
<td>1. Sept 27-28, 1897</td>
<td>Fort Worth, Tex</td>
<td>Mr. C P Johnson, Springfield, Ill.</td>
<td>Mr. D O Lively, Fort Worth, Tex</td>
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<td>2. Oct 11-12, 1898</td>
<td>Omaha, Neb.</td>
<td>Mr. C P Johnson, Springfield, Ill.</td>
<td>Mr. Taylor Riddle, Kan</td>
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<td>3. Oct 11-12, 1899</td>
<td>Chicago, Ill</td>
<td>Mr. C P Johnson, Springfield, Ill.</td>
<td>Mr. Mortimer Levering, Lafayette, Ind</td>
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<td>4. Oct. 2-3, 1900</td>
<td>Louisville, Ky</td>
<td>Mr. C P Johnson, Springfield, Ill.</td>
<td>Dr. F T Eisenman, Louisville, Ky</td>
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<td>5. Oct. 8-9, 1901</td>
<td>Buffalo, N.Y.</td>
<td>Dr. E P Niles, Va.</td>
<td>Dr. F T Eisenman, Louisville, Ky</td>
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<td>6. Sept. 23-24, 1902</td>
<td>Wichita, Kan.</td>
<td>Mr. W H Dunn, Tenn</td>
<td>Mr. Wm P Smith, Monticello, Ill</td>
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<td>7. Sept. 22-23, 1903</td>
<td>Denver, Colo.</td>
<td>Mr. W E Bolton, Woodward, Okla.</td>
<td>Mr. Wm P Smith, Monticello, Ill</td>
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<td>8. Aug. 23-24, 1904</td>
<td>St Louis, Mo</td>
<td>Dr. J C Norton, Ariz.</td>
<td>Mr. Wm P Smith, Monticello, Ill</td>
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<td>9. Aug. 15-16, 1905</td>
<td>Guthrie, Okla.</td>
<td>Mr. Wm P Smith, Monticello, Ill.</td>
<td>Dr. S H Ward, St Paul, Minn</td>
</tr>
<tr>
<td>10. Aug. 15-16, 1906</td>
<td>Springfield, Ill</td>
<td>Mr. M H Hankins, Quanah, Tex.</td>
<td>Dr. S H Ward, St Paul, Minn</td>
</tr>
<tr>
<td>11. Sept. 16-17, 1907</td>
<td>Richmond, Va.</td>
<td>Dr. D F Luckey, Columbia, Mo</td>
<td>Dr. C E Cotton, St Paul, Minn</td>
</tr>
<tr>
<td>12. Sept. 14-16, 1908</td>
<td>Wash, D C</td>
<td>Dr. W H Dalrymple, Baton Rouge, La</td>
<td>Dr. C E Cotton, St Paul, Minn</td>
</tr>
<tr>
<td>14. Dec. 5-7, 1910</td>
<td>Chicago, Ill</td>
<td>Dr. John F Devine, Goshen, N.Y.</td>
<td>Mr. J J Ferguson, Chicago, Ill</td>
</tr>
<tr>
<td>15. Dec. 5-6, 1911</td>
<td>Chicago, Ill</td>
<td>Dr. Macyeck P Ravenel, Madison, Wis</td>
<td>Mr. J J Ferguson, Chicago, Ill</td>
</tr>
<tr>
<td>16. Dec. 3-5, 1912</td>
<td>Chicago, Ill</td>
<td>Dr Peter F Bahnson, Atlanta, Ga.</td>
<td>Mr. J J Ferguson, Chicago, Ill</td>
</tr>
<tr>
<td>17. Dec. 2-4, 1913</td>
<td>Chicago, Ill</td>
<td>Dr. S H Ward, St Paul, Minn</td>
<td>Mr. J J Ferguson, Chicago, Ill</td>
</tr>
<tr>
<td>18. Feb. 16-18, 1914</td>
<td>Chicago, Ill</td>
<td>Dr J I Gibson, Des Moines, Iowa</td>
<td>Mr. J J Ferguson, Chicago, Ill</td>
</tr>
<tr>
<td>19. Dec. 2-3, 1915</td>
<td>Chicago, Ill</td>
<td>Dr. O E Dyson, Springfield, Ill.</td>
<td>Mr. J J Ferguson, Chicago, Ill</td>
</tr>
<tr>
<td>20. Dec. 5-7, 1916</td>
<td>Chicago, Ill</td>
<td>Dr J G Wills, Albany, N Y.</td>
<td>Dr. S H Ward, St Paul, Minn</td>
</tr>
<tr>
<td>21. Dec. 3-5, 1917</td>
<td>Chicago, Ill</td>
<td>Dr. M Jacob Knxville, Tenn.</td>
<td>Dr. S H Ward, St Paul, Minn</td>
</tr>
<tr>
<td>22. Dec. 2-4, 1918</td>
<td>Chicago, Ill</td>
<td>Dr G W Dumphry, Lansing, Mich.</td>
<td>Dr D M Campbell, Chicago, Ill</td>
</tr>
<tr>
<td>23. Dec. 1-3, 1919</td>
<td>Chicago, Ill</td>
<td>Dr S F Musselman, Frankfort, Ky</td>
<td>Dr D M Campbell, Chicago, Ill</td>
</tr>
<tr>
<td>24. Nov 29-30-Dec. 1, 1920</td>
<td>Chicago, Ill</td>
<td>Dr W F Crowe, Bismarck, N D</td>
<td>Dr Theo. A Burnett, Columbus, Ohio</td>
</tr>
<tr>
<td>25. Nov 28-30, 1921</td>
<td>Chicago, Ill</td>
<td>Dr T E Munce, Harrisburg, Pa</td>
<td>Dr Theo. A Burnett, Columbus, Ohio</td>
</tr>
<tr>
<td>26. Dec 6-8, 1922</td>
<td>Chicago, Ill</td>
<td>Dr W J Butler, Helena, Mont</td>
<td>Dr O E Dyson, Kansas City, Mo</td>
</tr>
<tr>
<td>27. Dec 5-7, 1923</td>
<td>Chicago, Ill</td>
<td>Dr. J G Ferneyough, Richmond, Pa</td>
<td>Dr O E Dyson, Kansas City, Mo</td>
</tr>
<tr>
<td>28. Dec 3-5, 1924</td>
<td>Chicago, Ill</td>
<td>Dr J H McNeil, Trenton, N J.</td>
<td>Dr O E Dyson, Wichita, Kan</td>
</tr>
<tr>
<td>29. Dec 2-4, 1925</td>
<td>Chicago, Ill</td>
<td>Dr John R Mohler, Wash., D.C.</td>
<td>Dr O E Dyson, Wichita, Kan</td>
</tr>
<tr>
<td>30. Dec 1-3, 1926</td>
<td>Chicago, Ill</td>
<td>Dr L Van Es, Lincoln, Neb.</td>
<td>Dr O E Dyson, Wichita, Kan</td>
</tr>
<tr>
<td>31. Nov 30-Dec. 1-2, 1927</td>
<td>Chicago, Ill</td>
<td>Dr C A Cary, Auburn, Ala.</td>
<td>Dr O E Dyson, Wichita, Kan</td>
</tr>
<tr>
<td>32. Dec 5-7, 1928</td>
<td>Chicago, Ill</td>
<td>*Dr Chas. G Lamb, Denver, Colo</td>
<td>Dr O E Dyson, Wichita, Kan</td>
</tr>
<tr>
<td>33. Dec 4-6, 1929</td>
<td>Chicago, Ill</td>
<td>*Dr Chas. G Lamb, Denver, Colo</td>
<td>Dr O E Dyson, Wichita, Kan</td>
</tr>
<tr>
<td>Date</td>
<td>Place of Meeting</td>
<td>President</td>
<td>Secretary</td>
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</tr>
<tr>
<td>Dec. 3-5, 1930</td>
<td>Chicago, Ill.</td>
<td>Dr. A. E. Wight, Wash., D.C.</td>
<td>Dr. O. E. Dyson, Wichita, Kan</td>
</tr>
<tr>
<td>Dec. 2-4, 1931</td>
<td>Chicago, Ill.</td>
<td>Dr. J. W. Connuway, Columbia, Md</td>
<td>Dr. O. E. Dyson, Wichita, Kan</td>
</tr>
<tr>
<td>Nov. 30-Dec 1-2, 1932</td>
<td>Chicago, Ill.</td>
<td>Dr. Peter Malcolm, Des Moines, Iowa</td>
<td>Dr. O. E. Dyson, Wichita, Kan</td>
</tr>
<tr>
<td>Dec. 6-8, 1933</td>
<td>Chicago, Ill.</td>
<td>Dr. E. T. Faulder, Albany, N.Y.</td>
<td>Dr. O. E. Dyson, Wichita, Kan</td>
</tr>
<tr>
<td>Dec. 5-7, 1934</td>
<td>Chicago, Ill.</td>
<td>Dr. T. E. Robinson, Providence, R.I.</td>
<td>Dr. O. E. Dyson, Wichita, Kan</td>
</tr>
<tr>
<td>Dec. 4-6, 1935</td>
<td>Chicago, Ill.</td>
<td>Dr. Edward Records, Reno, Nev.</td>
<td>Dr. O. E. Dyson, Wichita, Kan</td>
</tr>
<tr>
<td>Dec. 2-4, 1936</td>
<td>Chicago, Ill.</td>
<td>Dr. Walter Wisnicky, Madison, Wis.</td>
<td>Dr. R. L. Enos Day, Chicago, Ill</td>
</tr>
<tr>
<td>Dec 1-3, 1937</td>
<td>Chicago, Ill.</td>
<td>Dr. R. W. Smith, Concord, N.H.</td>
<td>Dr. R. L. Enos Day, Chicago, Ill</td>
</tr>
<tr>
<td>Nov. 30-Dec 1-2, 1938</td>
<td>Chicago, Ill.</td>
<td>Dr. D. E. Westmoreland, Frankfort, Ky</td>
<td>Dr. R. L. Enos Day, Chicago, Ill</td>
</tr>
<tr>
<td>Dec. 6-8, 1939</td>
<td>Chicago, Ill.</td>
<td>Dr. J. L. Axby, Indianapolis, Ind.</td>
<td>Dr. Mark Welsh, College Park, Md</td>
</tr>
<tr>
<td>Dec. 4-6, 1940</td>
<td>Chicago, Ill.</td>
<td>Dr. H. D. Port, Cheyenne, Wyo.</td>
<td>Dr. Mark Welsh, College Park, Md</td>
</tr>
<tr>
<td>Dec. 3-5, 1941</td>
<td>Chicago, Ill.</td>
<td>Dr. E. A. Crossman, Boston, Mass.</td>
<td>Dr. Mark Welsh, College Park, Md</td>
</tr>
<tr>
<td>Dec. 2-4, 1942</td>
<td>Chicago, Ill.</td>
<td>Dr. I. S. McAdory, Auburn, Ala.</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Dec. 1-3, 1943</td>
<td>Chicago, Ill.</td>
<td>Dr. W. H. Hendricks, Salt Lake City, Utah.</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Dec. 6-8, 1944</td>
<td>Chicago, Ill.</td>
<td>Dr. J. M. Sutton, Atlanta, Ga.</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Dec. 5-7, 1945</td>
<td>Chicago, Ill.</td>
<td>Dr. C. U. Duckworth, Sacramento, Calif.</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Oct. 4-6, 1946</td>
<td>Chicago, Ill.</td>
<td>Dr. William Moore, Raleigh, N.C.</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Dec. 3-5, 1947</td>
<td>Chicago, Ill.</td>
<td>Mr. Will J. Miller, Topeka, Kan</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Oct. 13-15, 1948</td>
<td>Devner, Colo.</td>
<td>Dr. Jean V. Knapp, Tallahassee, Fla</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Oct 12-14, 1949</td>
<td>Columbus, Ohio</td>
<td>Dr. T. O. Brandenburg, Bismarck, N.D.</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Nov. 1-3, 1950</td>
<td>Phoenix, Ariz.</td>
<td>Dr. C. P. Bishop, Harrisburg, Pa.</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Nov. 14-16, 1951</td>
<td>Kansas City, Kan.</td>
<td>Mr. F. E. Molin, Denver, Colo.</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Oct. 29-31, 1952</td>
<td>Louisville, Ky.</td>
<td>Dr. Ralph L. West, St. Paul, Minn.</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Sept 23-25, 1953</td>
<td>Atlantic City, N.J.</td>
<td>Dr. T. Childs, Ottawa, Canada.</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Nov. 10-12, 1954</td>
<td>Omaha, Neb.</td>
<td>Dr. T. C. Green, Charleston, W Va.</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Nov. 16-18, 1955</td>
<td>New Orleans, La.</td>
<td>Dr. H. F. Wilkins, Helena, Mont.</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Nov. 28-30, 1956</td>
<td>Chicago, Ill.</td>
<td>Dr. A. L. Brueckner, Baltimore, Md</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Nov. 13-15, 1957</td>
<td>St. Louis, Mo.</td>
<td>Dr. G. H. Good, Cheyenne, Wyo.</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Nov. 4-6, 1958</td>
<td>Miami Beach, Fla.</td>
<td>Dr. John G. Milligan, Montgomery, Ala</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Dec. 15-18, 1959</td>
<td>San Francisco, Calif.</td>
<td>Mr. F. G. Buzzell, Augusta, Me.</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Oct. 3-Nov 1-3, 1961</td>
<td>Minneapolis, Minn.</td>
<td>Dr. A. P. Schneider, Boise, Idaho</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Oct. 30-31, Nov 1-2, 1862</td>
<td>Washington, D.C.</td>
<td>Dr. W. L. Bendix, Richmond, Va</td>
<td>Dr. A. Hendershott, Trenton, N.J</td>
</tr>
<tr>
<td>Date</td>
<td>Place of Meeting</td>
<td>President</td>
<td>Secretary</td>
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</tr>
<tr>
<td>67 Oct. 15-18, 1963</td>
<td>Albuquerque, N.M.</td>
<td>Dr. T. J. Grennan, Jr., Providence, R.I</td>
<td>Dr. R. A. Hendershott, Trenton, N.J.</td>
</tr>
<tr>
<td>68 Oct. 19-23, 1964</td>
<td>Memphis, Tenn</td>
<td>Dr. L. A. Rosner, Jefferson City, Mo.</td>
<td>Dr. R. A. Hendershott, Trenton, N.J.</td>
</tr>
<tr>
<td>70 Oct. 10-14, 1966</td>
<td>Buffalo, N.Y.</td>
<td>Dr. C. L. Campbell, Tallahassee, Fla</td>
<td>Dr. R. A. Hendershott, Trenton, N.J.</td>
</tr>
<tr>
<td>71 Oct. 16-20, 1967</td>
<td>Phoenix, Ariz.</td>
<td>Dr. Grant S. Kaley, Albany, N.Y.</td>
<td>Dr. R. A. Hendershott, Trenton, N.J.</td>
</tr>
<tr>
<td>72 Oct. 6-11, 1968</td>
<td>New Orleans, La</td>
<td>Dr. John F. Quinn, Lansing, Mich</td>
<td>Dr. W. L. Bendix, Richmond, Va.</td>
</tr>
<tr>
<td>76 Nov. 5-10, 1972</td>
<td>Miami Beach, Fla</td>
<td>J. C. Shook, Mechanicsburg, Pa.</td>
<td>Dr. W. L. Bendix, Richmond, Va.</td>
</tr>
<tr>
<td>80 Nov. 7-12, 1976</td>
<td>Miami Beach, Fla</td>
<td>H. E. Goldstein, Columbus, Ohio</td>
<td>Dr. W. L. Bendix, Richmond, Va.</td>
</tr>
<tr>
<td>83 Nov. 28, Nov. 2, 1979</td>
<td>San Diego, Ca.</td>
<td>T. F. Zweigart, Raleigh, N.C.</td>
<td>Dr. J. C. Shook, Hyattsville, Md.</td>
</tr>
<tr>
<td>84 Nov. 2-7, 1980</td>
<td>Louisville, Ky.</td>
<td>B. W. Hawkins, Ontario, Or.</td>
<td>Dr. J. C. Shook, Hyattsville, Md.</td>
</tr>
<tr>
<td>85 Oct. 11-16, 1981</td>
<td>St. Louis, Mo</td>
<td>L. W. Hinchman, Indianapolis, In</td>
<td>Dr. J. C. Shook, Hyattsville, Md.</td>
</tr>
<tr>
<td>86 Nov. 7-12, 1982</td>
<td>Nashville, Tn</td>
<td>G. B. Rea, Salem, Or.</td>
<td>Dr. J. C. Shook, Hyattsville, Md.</td>
</tr>
</tbody>
</table>

Resigned Dec. 12, 1977

+ This was the last meeting of the Interstate Association of Livestock Sanitary Boards
INVOCATION AND MEMORIAL SERVICE

F. James Schoenfeld, DVM
Salt Lake City, Utah

Our Father, who art in Heaven, hallowed be thy name. Thy will be done on earth as it is in heaven.

Father in Heaven, we have assembled this night in the capacity of the 87th Annual Meeting of the United States Animal Health Association and the 26th Annual Conference of the American Association of Veterinary Laboratory Diagnosticians here at the Saharara, Las Vegas in the great State of Nevada. We ask that thy spirit might be with us throughout our meetings.

We are grateful for the stewardship that we have concerning the Animal Kingdom and ask that we might exercise this knowledge for the benefit of mankind. We pray that we might gain in knowledge and ability at these meetings and ask for blessings on those who instruct and teach us.

We are grateful for the leadership of our organizations as they devote their time and talents that these organizations may function properly. We are indeed grateful for the Staff who are dedicated to the service of these organizations especially our Ella and our Linda who correlates so much for us.

We are thankful for the facilities of this hotel to provide us with the materials needed to make this a successful meeting and conference.

We pray that we may gain the knowledge and the desire to prepare us for future challenges in our various fields of Animal Health and Veterinary diagnostics.

We pray for our families who are at their various residences throughout the country and ask that when we have finished our meetings we can return in safety and find all is well.

We are grateful for this Choice land of America, especially for these United States and we pray for the Leaders of this Nation and leaders of other Nations throughout the world that we may all work together that peace and progress of Animal and human relations may continue.

We pray for those who are ill among us especially those families who have lost loved ones and have cause to mourn.

We offer this prayer unto thee and ask for thy continued guiding hand in the Name of Jesus Christ.

Amen

1983 Deceased

Mrs. Kinney—wife of Dr. T. B. Kinney, Administrator of ARS, Washington, DC
Mr. Mark Trask—Elm Springs, South Dakota
Dr. Richard A. Kern—Wynnewood, Pennsylvania, July 30, 1982
Dr. A. F. Ranney—Putney, Vermont, December 23, 1982
Dr. Carl J. Norden, Jr.—Lincoln, Nebraska, June 1, 1983
Dr. W. E. Lyle—Edgerton, Wisconsin, August 23, 1983
Dr. Victor Schroeder—Mexico, DF, July 29, 1983
Dr. Billy N. Horstman—Salt Lake City, Utah, April 29, 1983

Mr. President, Members of U.S. Animal Health Association, and American Association of Diagnosticians, Ladies and Gentlemen; It is our custom that we pause for a moment in Reverence, Silent Prayer and Meditation to pay tribute and honor to those friends and colleagues who have completed their Mortal Lives here on earth and their spirits have passed on to paradise.
RESPONSE TO WELCOME
John W. Holcombe, DVM
Austin, Texas

Thank you Mr. Ballow for the very warm welcome to the City of Las Vegas and the storied State of Nevada. Those of us who have experienced the vast differences of the livestock industry under arid and semi-arid range conditions still marvel at the strength of this western land. Water is the usual essential that transforms desert into a city such as we are enjoying. But in this case I think green paper is the essential.

I think the real purpose of the USAHA will again be signified during this meeting. Producers and their allied groups will meet with those of us in disease diagnosis and control in an effort to give this country disease programs that are epidemiologically sound and affordable to those producers they are designed to protect.

I remind you that the USAHA started in September 1897, when Livestock Commissioners from eight states, including Texas, met with representatives from the U.S. Bureau of Animal Industries. This group met at the Fort Worth Stockyards, and formed the Interstate Association of Livestock Sanitary Boards to foster uniform procedures between the states in controlling the spread of animal diseases.

We in Texas welcome this organization's first return to its birthplace. Eighty seven years is a long time to stay away from the City and State where it came into being.

Fort Worth is still the gateway to the West, just as it was when USAHA was a fledgling organization.

Both USAHA and Fort Worth have made great strides. Fort Worth is now a great metropolitan center, but still retains its down home attributes. USAHA has become nationwide and international in scope, and it strives to retain its down to earth outlook and practicality.

There will be another celebration when Veterinary Services celebrates its 100th year since Congress acted to aid in protecting the states from the spread of animal diseases.

We hope to make this next meeting one that fits the occasion. Have a good time here, work hard, but keep 1984 in mind when you will come to the birthplace of our Association.

Thank you.
Mr. President, Ladies and Gentlemen.

My presence here in Las Vegas at your joint annual USAHA and AAVLD meeting does not only mean a honour for me, but it is also a great pleasure, because it is the first time that I am visiting the U.S.A., the country with which the Dutch have so many lasting contacts. We all remember Peter Stuyvesant, the dutch governor of New-Amsterdam (1664) and your bicentennial which so clearly demonstrated the good relations between our two countries.

This opening address gives me an opportunity to tell you something about animal health at the other side of the Atlantic, thus about the E.E.C.

— the O.I.E.

and about the Netherlands,
together with some thoughts about the relations of my country and the EC with the U.S.A.

By instituting a common market in 1958 and by gradually bringing the economic policies of the Member States closer together, the EC's objectives are in general the promotion of:

— "a harmonious development of economic activities throughout the community"

— "a continuous and balanced expansion"

— "an increased stability"

— "an accelerated raising of the standard of living"

— "closer relations between its Member States".

The EC, to achieve these, aims, for instance, at the elimination, of customs duties and of quantitative restrictions in regard to the importation and exportation of goods common agricultural and transport policies the establishment of a common customs tariff a common commercial policy towards third countries and the abolition, of the obstacles to the free movement of persons, services and capital.

The result of this abolition of all obstacles will be that supply and demand of all 10 countries will be combined and every product will have a bigger market. One important aspect should always be remembered. It distinguishes the EC from all other international alliances, viz. the willingness in principle of all the Member States to relinquish part of their national sovereignty and to accept instead supranational rules which are sub-
servient to the national statutory regulations.

The commercial traffic can be facilitated by removing—step by step—the impeding measures in the field of finance, economics and health.

So already from the start veterinary legislation had to be harmonized.

**HOW TO HARMONIZE LEGISLATION?**

Two main bodies of the EC are responsible. The initiative is taken by the *Commission*, the engine of the EC", *she proposes*! After consultation of the Member States, the proposal is sent to the *Council. She decides! This Council of Ministers* is the political executive body of the EC.

During the procedure a lot of preparatory work is done in expert working groups of the Commission and the Council. Although there is a *European Parliament*. Her possibilities are very limited, in fact she has only budgetary responsibilities.

**INTRODUCTION**

The existing legislation in the veterinary field is important for the proper development of free trade in domestic animals and animal products. But it is evident to all, who are familiar with animal production, that this free movement must be done without spreading animal diseases or toxic substances, which may be a health hazard to the human populations. Producers, traders and others responsible for the planning and management of animal production all accept that certain animal health and public health requirements are used in relation to trade. A high animal health level is an advantage to the producer, and high public health standards are reasonable from the consumers' point of view.

It is evident that such requirements must be justified and relevant. If not, there is a risk that they may be used to create barriers to trade, and result in distortion of competition. This is why the EC is harmonizing the veterinary legislation of the 10 Member States. One important area of our legislation covers the veterinary requirements for trade. It is based on the wish of simplifying veterinary control procedures, especially at the points of frontier passage.

**TRADE GUARANTEES**

The basis of the animal and public health guarantees, which are given in relation to trade in the EC, is mutual confidence; confidence in the veterinary control system of the Member State where the product is made.

This confidence may be obtained by the introduction of common harmonized regulations for the official veterinary control by accepting the same methods of diagnosis of diseases, and last but not least by practicing the same disease eradication procedures.
At this moment EC harmonization has been introduced for intra-Community trade in live cattle and pigs, and for fresh meat and meat products of domestic animals. Common measures are also being introduced for import of these products from Third Countries.

THE ANIMAL HEALTH LEVEL IN THE EC.

Veterinary control in relation to trade in animals or animal products can be simplified by establishing a common animal health level. The highest possible animal level is, therefore, an advantage for Community trade, just as it may also be an important basis for improving the economy of animal production.

I would like to give you a short survey of the plans for dealing with different contagious diseases.

A study of the presence and distribution in Europe of classical contagious diseases among domestic animals, e.g. bovine tuberculosis, brucellosis and leukosis, as well as some of the classical epizootics like FMD, classical swine fever and Newcastle disease, unveils a considerable variation from one area to another, while the preventive measures used by the Member States follow two different main principles:

1) no systematic vaccination and stamping-out of the infected herd in case of emergency OR

2) systematic vaccination WITH stamping out OR with limited elimination of infected animals.

The variations in presence and absence of diseases are the result of varying interests in disease control traditionally different structures of animal production, the varying climatic and geographical conditions adverse economic interests related to import or export and different economic resources for modernising animal production. The trade conditions of the Common Market tend to encourage the producers of the exporting countries to establish the best possible health level. The Community supports this by contributing financially to the eradication of bovine tuberculosis, brucellosis and leukosis in all Member States, where they are still prevalent. A remarkable reduction has been achieved, and the diseases will disappear within the not too distant future.

Classical swine fever has cost Europe many problems and losses. Epizootics have developed at regular intervals for several decades, although there has been a tendency to see the number of herds involved in the single epizootic reduced during recent years. At present the situation is not satisfactory, as SF has slowly spread from parts of Belgium to parts of the Netherlands and also into the German Federal Republic.

The Community has introduced a common eradication program for classical swine fever, according to which pig populations may gradually reach the status of official freedom. This status has already been reached by the United Kingdom, Ireland, Luxembourg and Denmark, and plans
have been adopted for the other Member States. The Community supports financially the elimination of infected animals from the pig population, and it is hoped that these measures may accelerate the final elimination.

The FMD situation in the Community is in general satisfactory. Outbreaks have become rare, but the rather limited epizootics which have been seen in the United Kingdom and Denmark, oh irony, countries without vaccination programs, have reminded us all about the grave consequences this disease may have for both international trade and national economy. The national rules and the Community rules for intra-Community trade are usually adequate to prevent spread, and the consequences for the trade between the Member States have been limited to the minimum by regionalisation as a result of the consultations and agreements between the Member States, which take place in the frame of the Standing Veterinary Committee.

VETERINARY CONTROL OF IMPORTS FROM THIRD COUNTRIES

By adopting internal rules it is consequently necessary to protect the Community against introduction of diseases from outside therefore criteria for importation of live animals and fresh meat from third countries have been established. The contagious diseases which are not tolerated in Europe by the Member States, and which could be imported by animals or fresh meat, have been defined and it has been decided to avoid importation from those third countries in which the following diseases are present:

- fmd exotic types *)
- rinderpest *)
- contagious pl. pneumonia
- african swine fever *)
- teschen disease *)
- blue tongue 12 months
- vesicular stomatitis 6 months

*) meat.

and no vaccinations may take place against any of these diseases.

The Standing Veterinary Committee however has the possibility to declare regions of countries instead of the whole country free of these diseases!

At this moment about 40 third countries have been listed as free from these “exotic” diseases, and animal health criteria have been specified for the importation of fresh meat from there. The criteria for the importation of live cattle and pigs will be fixed by the Standing Veterinary Committee procedure within the coming years.

It is also worthwhile mentioning that good results have been obtained by adding special safety requirements to the animal health conditions, when
fresh meat of cattle is imported from third countries, in which the FMD situation is considerably less satisfactory than in the Community. In this case the risk of transmitting FMD virus by fresh meat importation to the Community may be reduced by maturation of the meat for 24 hours followed by deboning and removal of lymph nodes. Since these criteria were introduced a drop in the FMD outbreaks in importing Member States has been observed.

Because I have been mentioning the **Standing Veterinary Committee** several times and because it is an important one, viz. for the agreement of slaughterhouses, and import prohibitions of live cattle from the States, I will try to explain the procedure.

In **ALL** Common market legislation a Standing Veterinary Committee procedure has been mentioned in relation to certain legislative aspects on which detailed *executive decisions* have to be taken, such as:

- import bans or restrictions.
- detailed import conditions for animals and meat.
- agreement of slaughterhouses etc.
- disease eradication measures in case of emergency.

While examples in relation to the U.S. are:

- BT regionalisation
- slaughterhouse agreements.

Proposals for discussion and decision can be introduced by the Commission while a qualified majority is necessary for acceptance. Every member state has one representative, the Commission chairs the Committee.

There are 63 votes.

qualified majority is 45 votes.

If no majority can be reached, the proposal is sent to the Council of Ministers, depending on the urgency, within a fortnight or three months or decision has to be taken.

To conclude, the Treaty of Rome by which the EC was founded mentions the 4 following bodies:

the **Commission** the engine of the EC, the initiator of agriculture policies, such as prices, fish quota, negotiations with third countries and the like with some specified decisive power through Standing Committees by qualified majority.

the **Council**, the decisionmaker, unanimously in general.

the **European Parliament** not yet functioning as it should!

and the **Court of Justice**, to which appeal is possible if Member States feel that unjustified decisions have been taken.

**THE OFFICE INTERNATIONAL DES EPIZOOTIES**

The creation of an International Organisation such as the OIE could be
nothing but the result of a lengthy elaborative process in a favourable environment.

However, the long period of preparation which was necessary before the O.I.E. was brought to life resulted in that, from the very beginning, it was a strong body, well adapted to the tasks to be performed, because clear-sighted godfathers had supplied it with the necessary diplomatic, legal, scientific and professional possibilities.

It is unquestionable that the creation of the O.I.E. in 1924 was determined, in the long run, by the evolution of ideas concerning international veterinary co-operation, which was fostered by the International Veterinary Congresses.

Studies undertaken and encouraged by the first International Veterinary Congresses on the extent of the main epizootic diseases, and more particularly on that of Rinderpest, Foot-and-Mouth Disease, Rabies, Tuberculosis, etc., had pointed out to the Governments and to the Directions of national Veterinary Services the need to have an International Organisation for the control of epizootics.

The International Conference which met at Vienna in 1872, on the initiative of the Austrian Government, to study the measures which could be jointly taken to protect the whole of Europe against an epizootic of Rinderpest which was evolving at this time in Central Europe, made it possible to work out an international regulation the principles of which were later made the basis of modern sanitary legislations.

However, the dramatic appearance of Rinderpest in Western Europe in 1920 was the factor which caused a decisive action to be taken.

Professor Emmanuel LECLAINCHE, the founder of OIE, wrote about this the following:

"In 1920, Rinderpest suddenly appears in Belgium following the transit through the port of Antwerp of zebu-cattle coming from India and bound for Brazil. It causes a commotion which is all the more intense because the possibility for the disease to be brought by such a way had been by no means foreseen.

France then takes the initiative to convene an International Conference which all Countries are invited to attend. Forty-two States answer this appeal. The Conference (held in Paris from 25 to 28 May 1921) carries out an examination of the sanitary position, particularly with regard to Rinderpest, Foot-and-Mouth Disease and Dourine; it studies exchange of sanitary information between countries, as well as sanitary measures for exportation.

"The Conference expresses the wish that there should be created in Paris an international Bureau for the control of animal infectious diseases. Three of its members are entrusted the duty of putting themselves at the disposal of the French Authorities for facilitating the establishment of a
draft international Convention.

"In spite of the delays involved in negotiations carried out through diplomatic channels, the adherence of twenty eight States is obtained within less than three years and an "International Agreement" is signed by their representatives on 25 January 1924."

Nowadays, more than 100 countries are members of O.I.E.

Since its first General Session, held in 1927 the O.I.E. carries on its work under the authority of a Committee consisting of Delegates of the contracting Governments.

The President elect, chairs the annual Sessions while an administrative Commission represents OIE during the intervals between these Sessions.

The activities of the organisation concentrate upon
— the General Session, which discusses every year animal health topics and
— the work of several Commissions such as the FMD Commission.
the Zoo-Sanitary Code Commission
the Fish-Diseases and
Norms Commission.

One of these groups the Code Commission is worth mentioning, not only because Mr. John Attwell and myself are members, but because it tries since 1960 to facilitate international trade by harmonising animal health regulations in force in Member Countries.

It is the Forum in which international agreements should be made in order to liberalize trade as much as possible, providing for all the necessary measures to prevent the spread of epizootic diseases hence facilitating international trade in live animals, meat, semen and other products of animal origin.

The arrangements are published in the International Zoo-Sanitary Code.

The wording of the Chapters and Articles of the Code concerning the arrangements applicable to each of the serious contagious diseases is based on the following concepts:
— the first article determines the incubation for the disease concerned.
— the following articles reflect possibilities to countries free from the disease to prohibit the importation of animals and products.
— subsequent articles state clauses to be adopted by importing countries depending on the animal health status (incidence of diseases, vaccination programmes, etc.) of the exporting country, and above this:
— definitions of zones free or infected and several other necessary comprehensions (such as transport and inspection facilities, disinfection-procedures, welfare, etc.).
— notifications of diseases.
— organisation of veterinary administrations.
— diagnostic methods etc. can be found in the Zoo S. Code. 

The Code, thus offers ALL possibilities to the importing country to adopt the most satisfactory animal health conditions in regard to the exporting country.

Although as I said more than 100 countries unanimously accept the arrangements, they are still not put into practice generally. This is all together not so amazing because it started only 15 years ago and the arrangements are not obligatory!

Still it is good to notice, that more and more countries reflect to the requirements of the Code for their imports, *a good development*.

**THE NETHERLANDS.**

Last but not least I must tell you about my native country, probably one of the most remarkable countries of the world.

Imagine

37.000km² in which live:

— 14 mill. inhabitants (416 km²) from which.

25% lives in cities with > 100.000

12% in the countryside and

in agriculture < 6%

— together with 5.2 mill. head of cattle 85.000 herds

— 2.4 mill. dairy cattle 60.000

— 12 mill. pigs 44.000

— 80 mill. poultry 8.600

— 2 mill. dogs and cats

— together with horses, sheep, pets etc. and that below sea-level!

You realise of course from these figures, *that the dutch produce more than they need*.

More than 70% of the total production is exported from which 75% to the Commonmarket, a market with 260 mill. consumers!

But because the animal health rules for import and export between EC countries are the same, the Netherlands play also an important role as importing country.

This asks for a special attentive competent veterinary authority. Well we have one, in fact we have two, let me try to explain.

More than a hundred years ago, the what we call the veterinary service, a government body was founded. The most imported reason for this was to bring the eradication of pleuro-pneumonia, by stamping out, under state control.

Later on, in 1914, a field service was added in order to continue the necessary export.

This veterinary service still functions as the official organisation responsible for the
disease eradication
export and import
welfare
drug administration
training and education
development aid etc.

In the beginning of this century however, more and more farmers expressed the need to have their own organisation which could offer the aid and advice not available from the veterinary service nor from the practitioner. The government occupied itself with the safeguarding of the general health of the cattle population, the prevention and the control of certain serious contagious diseases, but, to ensure the profitability of livestock farming, coordinated control of a number of other diseases was necessary.

In 1919 the first regional animal health service was founded as a result of the negotiations between Frisian herdbook and Cooperative dairy farmers.

At present we have six regional services entrusted with tb-, brucellosis and EBL control, as well as mastitis, Johne's disease, IBR, Maedi-Visna and control over AI centres. These coordinated control systems always start on a voluntary basis, but after earning the confidence of the farming industry the schemes are made compulsory.

Results of all actions are:
freedom of:

bovine tuberculosis 56
bovine brucellosis 67
enz. bovine leucosis 80
SVD 75
NCD 77
fmfd 77

but there are many other diseases which cause economic losses. The free movement of animals confronted our country with diseases as aujeszky's, swine fever, IBR, ILT and a single case of S.V.D.

Because of the good relationships with other veterinary services, the availability of necessary information, also collected by agricultural attaches, good testing, facilities and a relatively disciplined industry we have however managed to avoid calamities.

This is a must, not only to avoid the economic losses for our farmers but also for the export industry, remember we do have to export 70% of our agricultural production.

But that is not the only reason that our trade policy is a liberal one, I believe that you all know that the dutch are very independent hard-working, loyal.

It is therefore not surprising that the dutch are champions of free trade,
but unfortunately this has become a dream in agriculture. Because of domestic agricultural and food policies, interventions like limitations on imports or exports, subsidization, etc. are undertaken. So far no country has been engaged in meaningful negotiations about trade barriers, I feel that it is time that we take a serious look in the mirror and think about what we preach! we and you the U.S. profess their support of a free trade policy. But what is our action?

International trade has to increase in order to avoid an economic crisis, world trade decreased in 1982 and the '83 Gatt Geneva conference appealed for strong action against protectionism.

I think, everybody agrees, but nothing is done about it, I might characterize the U.S. position as one in favor of a FREE trade policy for products you export (cattle, semen, etc.) but highly restrictive for products that are competitive with your own production. (meat, dairy products).

This is the field of the non-tariff barrier, the restrictions of veterinary or physisanitary nature.

In my opinion your attitude towards fmd, ncd, swine fever is overdone and is difficult to discuss!

Hardly any country outside the U.S. realises on what grounds a country will be placed on your black- or white lists. But on the other hand you expect the europeans to accept that EBL - IBR - Aujeszky - blue tongue - vesicular stomatitis are no threat to their livestock!

We are of course prepared to look for solutions, but your point of view is sometimes pretty hard to understand for your friends from the other side of the Atlantic. Just think about the restrictions on meat imports from Denmark for more than 10 months after the last outbreak or the import-ban for milkpowder from the U.K. after a single FMD-outbreak on the Isle of Wight.

This is the biggest actual problem, the risk that we do not understand each other or do not want to.

Think about the agreement of your slaughterhouses and the blue tongue problem. It is easy to misuse animal arguments for protectionism.

The need to have an increasing world market and the fact that agriculture will continue to exist (ours is based upon a tradition of 2000 years) as well as the good relations between the U.S. and the Netherlands (Europe) are not sufficient guarantee to avoid an economic warfare and although our animal health field is only a very minor one, we feel very strong about the necessity for cooperation.

Whether this is multilateral or bilateral cooperation it is the only way to solve our present and future problems!

What unites us is still more important than what us parts.

REPORT OF THE SECRETARY–TREASURER

J. C. Shook, V.M.D.

Mr. President, members and friends of USAHA and AAVLD and distinguished guests.

The staff of the office of the secretary hope you are having an enjoyable and productive meeting in Las Vegas. From our standpoint this meeting has gone very smoothly so far and the legitimate complaints have been minimum.

Our office has had a very busy year. As the committees become more involved in keeping pace with pertinent animal health and related problems, the demands for service from the secretary’s office continue to increase. We thank our dedicated girls Ella and Linda for keeping up with these demands and keeping a smile on their faces at the same time. Those of us who work for various agencies and institutions know that people with this kind of dedication and attitudes are a rare commodity these days.

We maintain our close working relationship with the various federal agencies, with AAVLD and the other allied groups that share our common interests and meet with us annually.

Registration management by Norm and Jay Powers has gone smoothly as always and this organization owes them a real debt of gratitude. They have truly become a part of us and we want to thank them personally.

The number who preregister continues to increase—this year 435 have preregistered. The system simplifies the procedure for the members and the association.

Just a few reminders to help make the meeting run smoothly and the preparation of the proceedings easier:

1) Resolutions from committees should not be included in a committee report, but turned in to the Resolutions Committee Chairman or the registration desk for consideration by the resolutions committee. The resolutions should be on the official forms available in the workroom and six copies presented to the Resolutions Committee Chairman.

2) Speakers should be reminded to turn in their papers to the session chairman at the completion of their presentation.

3) Committee Chairmen should report to the press room when their reports are finalized and present the pertinent data to a representative of the public relations committee.

We hope you enjoy Las Vegas and we look forward to seeing you all in Fort Worth next year.
ADDRESS OF THE PRESIDENT-ELECT

J. O. Pearce, Jr.
Okeechobee, Florida

Ladies and Gentlemen, Members of USAHA, AAVLD and Guests!!!!!

Thank you for this opportunity to express my appreciation to you for the honor bestowed upon me to serve as President for this coming year. To be successful and accomplish our goals for the USAHA I will need the full backing and support from each of you.

Let me now share with you my thoughts and objectives that I hope we can accomplish during this coming year. In my comments to you tonight I would like to mention a few items that affect you as a member and in some instances, action needs to be taken by you, the individual member.

1. The USAHA has changed its fiscal year from October 1 thru September 30 to a Calendar Year. The Board of Directors felt this would be less confusing to everyone; therefore, an audited copy of the financial statement will be mailed to the Executive Committee and to any member who requests a copy after December 31, 1983.

2. USAHA members should pay next year’s dues at the convention or as soon as possible thereafter. Lots of our members are only paying last year’s dues at this meeting. Please check and see if you are one of these members, your dues are due at the convention and if they are not paid by March 31, you will become a delinquent member. Please catch up as it will help our Association stay financially strong. Furthermore, in doing so there will be less confusion in the office. In order to serve on any committee, your dues must be current.

3. Persons wishing to serve on a committee should contact the Chairman of that committee. The Chairman in turn will confer with the President who will make the final decision on appointments. All notices of committee appointments will be sent out from our main office. In order to serve on a special sub-committee you must be a member of the regular committee unless you are given special consideration by the President.

4. The quarterly newsletter is our only connection between our office and you, the members. We send this to keep you updated on what is happening in your Association. Please read it. We know from some of the questions asked that this letter is not being fully read. Please do so because it costs your Association lots of money in postage to send this information to you.

5. Our Board of Directors met several times this past year with a committee of AAVLD to work out conflicts in our weeks convention schedule and we made program changes to keep from having conflicting schedules. I think it is important that we both meet the same week
and I expect to keep a good rapport between our organizations just as long as it is feasibly financially possible.

Now for some comments about the workings of our Organization. Since I have been a member for the last 20 years, I have seen all phases of allied industry grow in their membership to USAHA and participation input into the workings of our vast committees. It is great to have this input to show how the proposed changes will affect our industry in the field. This is what our job in USAHA is — to recommend to USDA changes in rules and regulations that are practical and not impossible to be carried out.

On membership, I feel you, the present members, are the key to more members. If you would carry in your car or truck a few application blanks and ask your friends and neighbors to join in with you in promoting the rules and regulations that govern the industries we could do more than double our membership in no time at all. It works — I have tried it already. You are the key. We can spend thousands of dollars in public relations as we have in the past year but accomplish very little. What about it — won't you help in this effort?

Our office staff is willing to help the Committee Chairman with sending out notices of committee meetings to any of the officers, but they do need a typed copy sent to them in Richmond. They cannot take memos over the phone because of interference from the other phones which can cause mistakes to be made, so please mail a typed copy. In this same line of thinking, all speakers who present papers on the program must turn in a copy immediately following his or her presentation so we can get it in the year book on time. Please remember to do this.

None of us knows what is ahead . . . the important thing is to use today wisely and well, and face tomorrow eagerly and cheerfully. Let us move forward with strong and active faith.

I invite all of you to join with me in helping to continue developing healthy animal welfare programs so that we can better the image of our Organization and of Industries.
Mr. J.O. Pearce, Jr., President-Elect, presents plaque to outgoing President, Dr. John R. Ragan, for his outstanding leadership for 1982-1983.

REMARKS BY THE PRESIDENT

John R. Ragan, D.V.M.
USAHA-AAVLD Joint Session 10-17-83 Las Vegas

Distinguished Guests, Ladies and Gentlemen,

I know very well how it feels to be sitting out there at this hour after a long and busy day.

Let me just say that it has been a once-in-a-lifetime pleasure and privilege to serve you during the past year. Most of what I have learned has increased my appreciation for the many talented and unselfish people who make possible an organization such as ours. I am more than ever convinced of the continuing need for a forum such as is provided here to discuss, debate, and recommend both technical and economic content of our nation's animal health programs and activities.

During the year, we have struggled to maintain the Association on a sound financial base with some degree of success. We also have developed clear policy for several operational processes which have heretofore been less than completely understood. I feel that the regional representatives input into the State-Federal Relations Committee has broadened our base
in a very positive manner.

We have addressed a number of problems with regard to registration and program scheduling between USAHA and AAVLD. We have solved some of the problems, and continue to have constructive dialogue regarding others.

Ample new challenges lie ahead of all of us. The impact of commerce in animal embryos is typical of a number of rapidly developing areas which require our attention.

As usual, the production of our Association has been made primarily by dedicated committee chairmen and members, and by our small but effective staff. (Ella asked me to say that).

I ask your pardon for my many shortcomings as president. I thank each who has contributed to our mutual goals. I forgive each who has created a problem.

I commend you to an able Board of Directors, Executive Committee, Committee Chairman, and my friend, President J. O. Pearce.

I hope to be able to contribute to USAHA in some manner for many years.
Mr. B.W. Hawkins, Administrator, presents Animal and Plant Health Inspection Service’s Animal Health Award to Dr. Harold E. Nadler, former State Veterinarian of New York.
REPORT OF THE COMMITTEE ON NOMINATIONS
AND RESOLUTIONS

The Committee on Nominations and Resolutions presents the following slate of officers for election at this meeting for your consideration. Their names will be posted on the bulletin board at the registrations desk for 24 hours according to our Bylaws:

President ...................................... J. O. Pearce, Jr.
                                      Okeechobee, Florida

President-Elect ............................. David U. Walker
                                      Montpelier, Vermont

First Vice President ........................ N. W. Kruse
                                      Lincoln, Nebraska

Second Vice President ................. John Hudelson
                                      Denver, Colorado

Third Vice President ..................... John Cobb
                                      Atlanta, Georgia

Treasurer ................................. J. C. Shook
                                      Annapolis, Maryland

Regional Representatives

Northeast ..................................... Victor LaBranche
                                      Boston, Massachusetts
                                      Everett Bryant
                                      Storrs, Connecticut

North Central ............................ Bill Gallagher
                                      Highmore, South Dakota
                                      Phil Bradshaw
                                      Griggsville, Illinois

South ........................................ Joe Finley, Jr.
                                      Encinal, Texas
                                      William Baisley
                                      Dalton, Georgia

West ........................................... R. H. McCapes
                                      Davis, California
                                      Olin H. Timm
                                      Dixon, California
RESOLUTIONS
United States Animal Health Association
Passed, October 21, 1983
Las Vegas, NV

RESOLUTION No. 1
Source: Committee on Animal Welfare
Subject Matter: Bluetongue, Serotype 2

Resolution
BE IT RESOLVED that the USAHA urges that USDA/APHIS institute immediately a sentinel herd survey and other available means of monitoring livestock populations to define the distribution of BT Serotype 2 in the United States.

RESOLUTION No. 2
Source: Committee on Sheep and Goats
Subject Matter: Caprine Arthritis

Resolution
THEREFORE BE IT RESOLVED, that USAHA request the USDA to continue and expand valuable research on caprine arthritis: and

BE IT FURTHER RESOLVED that Veterinary Services, Animal and Plant Health Inspection Service, appoint a work group of qualified government, academic, and industry representatives to define the nature and scope of caprine arthritis and control and eradication procedures.

RESOLUTION No. 3
Source: Committee on Sheep and Goats
Subject Matter: Caseous Lymphadenitis

Resolution
THEREFORE BE IT RESOLVED, that USAHA urge the United States Department of Agriculture to give high priority to research on caseous lymphadenitis; and be it further resolved that USDA, APHIS, appoint a group of qualified and interested academic, industry and Government representatives to define the nature and scope of this disease and control and eradication measures.
RESOLUTION No. 4
Source: Committee on Sheep and Goats
Subject Matter: Internal Parasites of Sheep and Goats

Resolution

THEREFORE BE IT RESOLVED, that the USAHA urge USDA to consider funding both immediate and long-term research to develop integrated parasite control approaches.

RESOLUTION No. 5
Source: Committee on Parasitic Diseases and Parasiticides
Subject Matter: Problems of Insecticide Resistance in Insects

Resolution

BE IT RESOLVED that the U.S. Animal Health Association urges the Agricultural Research Service, USDA, to support and undertake new research into the problem of insecticide resistance in insects, especially horn flies, affecting livestock.

RESOLUTION No. 6
Source: Committee on Rabies
Subject Matter: Rabies

Resolution

BE IT THEREFORE RESOLVED that USAHA recommends that procedures for dissemination of information concerning the most current techniques, vaccination procedures, and pre-and-post exposure immunization practices be reviewed to assure that all laboratories involved in the diagnosis of rabies be kept properly informed and that efforts be initiated to develop more uniform diagnostic methods for use by all such laboratories.

Since the U.S. Public Health Service is the lead agency in the control of rabies in the U.S., it is suggested this resolution be referred for their review.
RESOLUTION No. 7
Source: Committee on Tuberculosis and Johne's Disease
Subject Matter: Tuberculosis in Mexican Cattle Imports

Resolution

BE IT RESOLVED, the USAHA in cooperation with Veterinary Services, USDA form a special committee to review the importation criteria of Mexican cattle and determine if feasible requirements can be instituted which will safeguard the U.S. Cattle population.

RESOLUTION No. 8
Source: Committee on Import-Export
Subject Matter: Secretary: Advisory Committee — Foreign Animal Disease

Resolution

THEREFORE BE IT RESOLVED, that the USAHA recommends to USDA that this Advisory Committee be
(a) non-political
(b) have an adequate term of appointment
(c) appointment of replacements be staggered to provide continuity of experience.

RESOLUTION No. 9
Source: Committee on Import/Export Committee
Subject Matter: Bluetongue — Study Group

Resolution

THEREFORE, BE IT RESOLVED that a knowledgeable task force composed of regulatory, research, and livestock representatives be established to formulate adequate protocol to perform the necessary tests to identify B.T. in animals before they enter the United States from other countries and to establish methods for monitoring domestic livestock and wildlife that have come into the United States.
RESOLUTION No. 10
Source: Export Subcommittee
Subject Matter: Export Testing

Resolution

BE IT RESOLVED, that the USDA be encouraged to request foreign nations that require quarantine and retest of United States animals upon arrival in that country to request that appropriate samples be taken by a representative of that country or by an accredited USDA official and said samples will be tested in laboratories in the country of destination prior to said animals leaving the United States.

RESOLUTION No. 11
Source: Committee on Environmental Residues
Subject Matter: Mycotoxins as environmental residues

Resolution

THEREFORE, BE IT RESOLVED that USDA identify and allocate increased resources to evaluate mycotoxin occurrence and impact on food animal production and wholesomeness of food products derived from animals.
RESOLUTION No. 12
Source: Committee on Transmissible Diseases of Poultry and Other Avian Species
Subject Matter: Proposed Resolution

Resolution

NOW BE IT RESOLVED,

1. That bird or populations of birds known to harbor any Newcastle disease virus that produces a lethal infection in chickens or turkeys be prohibited from importation into the United States.

2. All velogenic strains of Newcastle disease virus should be considered exotic to the United States and should be eradicated when detected.

3. The possession and use of velogenic strains of Newcastle disease virus, such as GB, be limited to qualified laboratories under permit of the USDA.

4. That USDA implement the above recommendations and change terminology as required to clarify current regulations at the earliest possible date.

FURTHER, it is recommended that funds be made available to support research on methods for recognizing velogenic strains by more rapid methods than bird inoculation. Until such other methods are developed and validated, however, bird inoculation as presently employed should be continued except that production of viscerotropic lesions not be required to classify an isolate as velogenic.

RESOLUTION No. 13
Source: Committee on Professional Oversight
Subject Matter: Salmonella Typing Center

Resolution

THEREFORE, BE IT RESOLVED that a study be conducted by USDA to determine the feasibility of establishing a national salmonella research reference center with the capability to pursue epidemiological investigations of salmonella outbreaks, to serotype isolates and to employ advanced means of identification including plasmid fingerprinting.

BE IT FURTHER RESOLVED, if the foregoing study demonstrates the feasibility of establishing such a reference center that funds be requested by USDA to establish the center.
RESOLUTION No. 14
Source: Committee on Professional Oversight
Subject Matter: Brucellosis 1984 Budget

Resolution

THEREFORE BE IT RESOLVED, in order to avoid compromising the total Brucellosis Eradication Program and funding specifically for adjacent herd testing, fee basis practitioner work, and depopulation funds for the highly infected states and free states, the USAHA recommends FY 1984 brucellosis funding at the level $81.3 million approved by the House Appropriation Committee.

RESOLUTION No. 15
Source: Committee on Professional Oversight
Subject Matter: Certified Raw Milk

Resolution

THEREFORE BE IT RESOLVED, the USAHA hereby recommends that the Department of Health and Human Services proceed to the public hearing process to determine if restrictions should be placed on interstate shipment of unpasteurized raw milk in final packaged form.

BE IT FURTHER RESOLVED, the President of USAHA should make this recommendation known to the Secretary of the Department of Health and Human Services.

RESOLUTION No. 16
Source: Committee on Morbidity and Mortality
Subject Matter: Changing of Committee Name

Resolution

THEREFORE BE IT RESOLVED, that the name of the Committee on Morbidity and Mortality be changed to the Committee on Animal Disease Surveillance.
RESOLUTION No. 17
Source: Committee on Salmonella
Subject Matter: Salmonella

Resolution

THEREFORE BE IT RESOLVED, that the USAHA recommend to APHIS: 1. That they adopt a national policy of dealing with identified cases of fowl typhoid as though it were foreign disease and 2. that they develop a suitable program for salvaging critical genetic stock that might be infected by S. gallinarum.

RESOLUTION No. 18
Source: Committee on Pharmaceuticals, Pesticides and Related Toxicology
Subject Matter: BVM's Policy on Extra Label Drug Use in Food Animals

Resolution

THEREFORE, BE IT RESOLVED, the USAHA strongly urges the Bureau of Veterinary Medicine (BVM) to continue to cooperate with veterinary practitioners and livestock producers/animal owners to define "appropriate veterinary-client relationship" and to consider regulatory action regarding extra label drug use only when a veterinary-client relationship does not exist or if violative tissue residue levels occur.

RESOLUTION No. 19
Source: Committee on Pharmaceuticals, Pesticides and Related Toxicology
Subject Matter: Approval of Additional Uses for Animal Drugs

Resolution

THEREFORE, BE IT RESOLVED, that animal drug manufacturers and the Bureau of Veterinary Medicine (BVM) be encouraged to explore approval of additional uses for those animal drugs.

RESOLUTION No. 20
Source: Committee on Salmonellosis
Subject Matter: USAHA Serve As Co-Sponsor of International Symposium on Salmonella

Resolution

THEREFORE BE IT RESOLVED that USAHA officially support the International Symposium on Salmonella as a co-sponsor to the Symposium, which will be held on July 19 and 20, 1984 in New Orleans.
RESOLUTION No. 21
Source: Committee on Biologics
Subject Matter: Animal Biologics Regulation

Resolution

THEREFORE, BE IT RESOLVED that USDA, APHIS be requested to carefully consider the proposed definition of the term "Animal Biological Product" developed by the Animal Health Institute, as below.

The term "animal biological product" means any product represented as an animal biological product intended for use in the diagnosis, prevention, and cure of disease in animals, including any vaccine, bacterin, serum, antiserum, toxoid, antitoxin, allergen, diagnostic antigen or antibody, or analogous product, whether any of these products are of natural or synthetic origin, or result from synthesizing or altering antigenic components or similar technologies. A product is analogous to a vaccine, bacterin, serum, antiserum, toxoid, antitoxin, allergen, diagnostic antigen or antibody if it is intended to have a similar effect in the stimulation, modulation, or measurement of humoral, cell-mediated, or passive immunity.

RESOLUTION No. 22
Source: Committee on Biologics
Subject Matter: Animal Biologics Regulation

Resolution

THEREFORE, BE IT RESOLVED that USDA, APHIS be urged to carefully consider proposed modifications presented by members of the Biologics Committee and evaluate these suggestions carefully in consideration of future revisions of the draft legislation.

RESOLUTION No. 23
Source: Committee on Biologics
Subject Matter: Animal Biologics Regulation

Resolution

THEREFORE, BE IT RESOLVED the USAHA strongly support the general concept of the draft legislation with specific comment to come upon the introduction of the Bill.
RESOLUTION No. 24
Source: Committee on Professional Oversight
Subject Matter: "100 Years of Animal Health"

Resolution

NOW, THEREFORE, BE IT RESOLVED that the USAHA fully endorses the observance of "100 years of animal health" in 1984 and encourages its member organizations to hold appropriate ceremonies during their local, regional and national meetings and to otherwise honor the tremendous progress made in the past one hundred years to advance the health and productivity of America's livestock industry and protect America's animals and pets through research, cooperative endeavor and the use of sound, scientific principles.

RESOLUTION No. 25
Source: Committee on Epizootic Attack Plan
Subject Matter: Present Laws for Importation

Resolution

THEREFORE BE IT RESOLVED that a study should be conducted by APHIS and other interested organizations and individuals relative to desirable revisions of laws and regulations relating to importation of non domestic animals and birds.

RESOLUTION No. 26
Source: Committee on Epizootic Attack Plan
Subject Matter: Disease Producing Agents

Resolution

THEREFORE BE IT RESOLVED a subcommittee of the Epizootic Attack Committee should be appointed to review this situation and related issues and should be instructed to make recommendations to USAHA next year. A one year moratorium on approval of additional rural permanent postentry quarantine zoological facilities should be imposed by USDA, APHIS, Veterinary Services.
The following amendment properly presented and acted upon by the Executive Committee in session in Nashville, Tennessee, Thursday, November 11, 1982 was brought before the General Assembly of the United States Animal Health Association, Wednesday, October 19, 1983 for adoption.

Wherever it shall appear in the Constitution and Bylaws, strike the term “Executive Committee” and substitute the term “Board of Directors,” and wherever it shall appear in the Constitution and Bylaws, strike the term “Board of Directors” and substitute the term “Executive Committee.”

The amendment failed of adoption.
THE THREE HORSE EVENER

B.W. Hawkins, Administrator, APHIS, USDA

I'm delighted to be here with you again at the USAHA. I first attended a meeting of this organization in 1967. Later, I had the honor of being the first chairman of your Anaplasmosis Committee. More recently, I chaired the Brucellosis Committee for two years and was then elected president of your organization. I then chaired the Epizootic Attack Committee. Then I got this job—and my name's not on any committee now.

Over the years I have come to appreciate the valuable work that this association accomplishes through its committee system. This is a nuts-and-bolts, working organization. I have also developed a strong and lasting friendship with many of you. We have worked together to accomplish many good things. We have only to look at our strong and healthy U.S. animal agriculture to realize this.

In the past decade or two, the number of industry representatives within USAHA has grown significantly. This has made the job of those of us charged with the control of diseases and pests much easier—because we are communicating better with each other. This means that it is easier to get cooperation, because programs have become truly joint programs—a combined State–Federal–industry effort—not just Federal programs or State programs.

With a truly joint program, it is vitally important that each partner contributes his share—or the program is doomed to failure. A truly joint program puts a burden on industry and the various State governments, along with the Federal government.

I can best portray what I am talking about—and what I deeply feel—by using an example I call the “three horse evener.” Those of you who grew up on a farm before the advent of the tractor are no doubt familiar with the evener. For those who did not, let me explain. (VISUAL).

This configuration was put together originally when a farmer had a wagon load that was too much to pull for two horses, but not enough for four. Thus, a three-horse hitch was needed. But this arrangement required all three of them to lay into the collar with the same strength, or the weak or lazy horse would be sucked back under the wagon.

Our animal health programs are very similar to that wagon load. All of us—and by us I refer to the three-horse team of industry, the States and the Federal government—must put our shoulders to the wheel in about equal proportions. If one horse shirks, the load will soon be too great for the other two to pull. The program will falter and stagnate—and if on an uphill pull, begin to fall back . . . . perhaps out of control.

Let me make one more point using this same example. (VISUAL) I think you'll agree with me that we're all basically lazy; given the choice, we'd rather be the horse tied to the back of the wagon that's allowed to eat the hay without being hitched up. But if this happened, the load wouldn't move very far or very fast.
You can see that the horse in back is getting more benefit out of the load being pulled than the ones doing all the work. Several of our programs have this situation. For instance, we have industry people who have infected herds and are selling cattle at a higher price than they would get if the rest of us hadn't built up the reputation for U.S. cattle as being disease free. And some in the veterinary field that are less than scrupulous are living off the good reputation that this profession has rightfully earned over the years.

This must and will change. I promise you that wherever we find dead beats or crooks, we'll expose them for what they are.

Let me talk for a moment about one of my favorite subjects—compliance. This is something that I have been giving strong emphasis in recent months. I put our targets for compliance action into three categories:

First is the uninformed or the Johnny-come-lately.

Second is the violator.

And third is the crook!

Let me explain how I differentiate between the three. Number 1, the uninformed, can be broken down into several sub-groups.

(1) The very small producer or Johnny-come-lately and the very small practitioner or, in some cases, the older veterinarian.

The very small producer doesn't raise cattle for a living—often it's a symbol or status thing. If he has a few cows, he can wear boots and a cowboy hat and call himself a cattleman. These individuals really could care less about disease. Whether a cow has a live calf or raises it to maturity really isn't all that important—because these people are not in it for the money, but rather as a status symbol.

The Johnny-come-lately is usually the nonresident or affluent person who bought a cow ranch and doesn't understand all of the health requirements that are necessary to make a profitable operation.

These individuals need a concerted and full-blown educational program that is ongoing. Following the Brucellosis Technical Commission's report, this organization did a fair job, but it wasn't enough and we didn't keep it up. For a number of reasons—involving such things as budget, ceiling and other priorities—it hasn't been followed through on. We in APHIS are starting to review our efforts in this regard to see what can be done.

(2) The violator. This is how I classify the individual who knows he is doing wrong—but really doesn't know all of the ramifications of good animal health practices and how not following the rules can impact on his neighbors or the domestic livestock economy. He is not aware of the international consequences if our livestock are either perceived as being contaminated or—in the worst analysis—actually are contaminated.

We have a slogan on our Mexican border concerning prohibited items—“Even one can hurt.” This same message needs to get through to those individuals who feel that sending one cow to market without the proper testing or health certification really won't hurt.
This again behooves those of us in a leadership role to help get these individuals to understand the consequences of their actions or lack of actions. That is the major role of our compliance officers.

(3) The last category is the crook. We will spare nothing within our realm of responsibility or resources to prosecute these individuals, bring them to justice and sentence them for their crimes. For they are out and out crooks—on the wrong side of the law—who are doing what they are doing to make money at the expense of the rest of us. Right now we are on the verge of losing the best export market for live cattle this Nation has ever had. If we do, it will be because of unlawful and premeditated violation of our health standards and requirements by a few individuals.

We cannot, we will not, put up any longer with these crooks treading on the reputation that the rest of us have worked so hard and so long to build.

I am reminded that the Bureau of Animal Industry—the predecessor of APHIS—was formed one hundred years ago this coming year for these same express purposes: To create a healthy livestock industry and to build a reputation for healthy animals that would open up international markets to enhance the economic structure of that industry. Unless we reestablish compliance with our animal health requirements, we will lose the image and the reputation that took one hundred years to build.

Let me point to just a few of the many things that the BAI and its successor organizations accomplished—working in harness with the livestock industry and State animal health officials. For again, I must emphasize that this is a cooperative endeavor—and that these accomplishments could not have been attained had we not been working together as a team.

On September 26th, 1892—barely 3,000 days since the BAI had been born—it’s first assignment was completed: Contagious bovine pleuropneumonia had been eradicated. The tools of quarantine, destruction of diseased animals and the cleaning and disinfection of contaminated premises had wiped out this disease—in this case even before the causative agent was known!

The discovery by three BAI scientists—Theobald Smith, Cooper and Curtice and Fred Kilbourne—that Texas fever was spread by a tick was a scientific breakthrough. And not just in the veterinary field. For the discovery that insects could spread disease led to control of yellow fever and malaria in humans . . . and enabled U.S. workers to complete the Panama Canal where two attempts by the French had failed.

We have wiped out six outbreaks of foot-and-mouth disease since the turn of the century—the last in 1929. Tough import laws after that last outbreak have enabled us to remain free of this and other devastating foreign diseases.

We conquered two serious horse diseases—dourine and glanders.

Research and regulatory actions—and the first significant peaceful use of atomic energy—have enabled us to eliminate screwworms from the
United States. And now we are working with Mexico to help move the barrier of sterile flies south to the Isthmus of Tehuantepec to protect the livestock industries of both countries. And here again, this was a team effort—ranchers in the Southwest put up four-and-a-half million dollars of their own money to get the program going in that area.

Other disease eradication campaigns have been carried out successfully, the most recent being one many of you were intimately involved with. I refer of course to the eradication of hog cholera. This was a "native" American disease—one that had become established over the course of a century and was endemic to the entire country. When we first tackled it, many said the job couldn't be done. But by working as a team—industry, the States and the Federal government—we wiped it out in just fifteen years and at a cost appreciably below what had originally been estimated.

When the United States was officially declared "hog cholera free" in January 1978, it had cost us one-hundred-forty million dollars to get the job done. But the cost to producers over that same period if there had been no program would have been a staggering 1.12 billion dollars! Eradication of hog cholera is perhaps the most significant accomplishment in our one-hundred-year history of combating animal disease.

I could go on . . . . but let me close by pointing out that even though we know we have accomplished much, we also know that our work has not always been recognized.

But for those of us assembled here—and for those concerned with keeping the healthiest livestock in the world—I would like to take my hat off to you and relate what Dr. B. T. Simms, the last chief of the Bureau of Animal Industries said in this respect.

"I believe on the whole we can be proud of what we have done, but we must be humble because we have so many tasks partly done or undone. If we have worked with our ears ever listening for the plaudits of the multitude, we have probably been disappointed. But if cattle on a thousand hills mean more to us than a monument of marble . . . . if a well-nourished and healthy population is more important than a complimentary resolution . . . . if the laughter of happy children is music to our ears, we can enjoy the long hours and hard days of our task . . . because we have helped bring these things to our country."
LOOSE HOUSING of ‘Special Fed’ Veal Calves
Terrence J. Seubert, President
Seubert Calf Ranches, Inc.
Dorchester, Wisc.

The raising of formula fed veal calves has had a brief history as compared to other forms of agricultural animal production. The industry spawned from Europe during the early 1950’s in the countries of Holland and France. Raising formula-fed veal in the United States was introduced in the early 1960’s. There were a series of factors responsible for bringing together all the necessary elements to make this a viable industry. The number of choice milk fed veal calves in this country was rapidly declining, thus adding to the already large numbers of young bob calves. There were huge amounts of low-priced dried skim milk powder in storage. Experiments utilizing various fats in milk replacer formulas for the production of veal initiated by Theobold Industries in the form of a grant to Dr. R. G. Warner at N.Y.S. College of Agriculture. Berliner and Marx was a quality veal distributor from New York City and developed a market for formula-fed veal calves. Provimi, a veal milk replacer manufacturer in Europe, supported a U.S. Provimi Co. (founded by Aat Groenevelt and Paul Brandt) and established a complete veal raising program. This brought together all the necessary elements to make the industry flourish.

Although the majority of formula-fed veal is raised in confinement barns using the individual stall method, loose house raising is older than the veal industry itself. Before there was a veal feeding program, most calves were raised in small group pens on bedding. In the early 1960’s the Nursette Company from Rogers, Minnesota introduced a mechanical automatic feeder to feed 12-15 calves. It was used by both dairy farmers and commercial calf raisers to start dairy and feeder calves. The machine would heat and meter water into a mixing bowl, release a measured amount of powder and then mix. The bowl contained an attached nipple, thus permitting the calf to suck free choice.

In the early 1970’s a French company introduced the Maternal Robot for sale in the United States. This machine had two basic improvements: (1) It could handle up to 40 calves at a time, and (2) A person was able to adjust the concentration (powder to water ratio) as to the needs of the calf. This machine was also used for starting calves and to some extent to raise veal.

Until recently, most loose housing systems have had problems which have caused this system to be a disadvantage compared to the individual stall system:

1. Transmission of disease was greater
   a. Calves drink from the same nipple
   b. Calves eat bedding which may be contaminated with urine and feces
   c. Calves lay on contaminated bedding

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d. Calves suck each others naval, thus ingesting urine from other calves.

2. Difficulty in detecting stress and disease
   a. Inability to see feces in the manure pack
   b. More difficult to observe calves individually
   c. Calves seemed to be more stressed from being full all the time

3. Problems with bedding and manure
   a. Mechanical pneumonia caused by dust and mold particles in the bedding
   b. Increased respiratory disease because of the high ammonia levels from the manure pack
   c. Manure is a natural medium for flies, maggots, and parasites
   d. The calves ingest bedding which cause impaction of the stomach and intestines thus causing a lower dressing % and lower price
   e. The labor and investment needed for manure handling

4. Reduced control over feeding and handling
   a. Unknown amount of feed intake per calf
   b. More difficult to identify and treat stressed calves quickly
   c. Mechanical breakdown of the machine
   d. The overseer may be more lax because he thinks the calves are caring for themselves
   e. More difficult to handle calves for diagnostic purposes

Because of preliminary disadvantages, the veal industry has until this time, adopted the individual stall system. Both systems have had trial and error, but the stall system has been more successful in the 1960's and 1970's. The individual stall system has better enabled us to develop this industry in the following ways:

1. Diagnostic testing
   a. Taking rectal temperatures of the whole group of calves
   b. Extensive blood testing
   c. Bacterial and viral lab work

2. Individual treatments according to the specific disease of each calf within the group

3. Better field trials could be conducted
   a. Nutritional requirements had to be established
   b. Field personnel had to be trained
   c. It was easier for growers to learn better animal husbandry by caring for calves on a 1 to 1 basis

4. Building requirements had to be established
   a. Temperature
   b. Humidity
   c. Fresh air movement

It has taken many years to perfect a program to control disease, good environment and proper nutrition. This was the first and necessary step on
behalf of animal welfare. The loose housing program is a method of veal production that has been misunderstood and mismanaged in the United States. We are still gathering information to perfect a program for the loose housing of veal calves.

The Nursette and Maternal Robot machines with modifications and new improvement are still on the market today. Also the 1980's to date have brought us three more machines for loose housing system:

1. Provimi Company is currently testing a Swiss made machine
2. Quantock is importing and marketing their English machine
3. American Feeds is marketing the German made Forster Technik machine

I am currently using and marketing the Forster Technik machine through American Feeds and Livestock Co., Inc. Because of my experience with this automatic feeding machine, I will refer to the Forster Technik machine in the remainder of my report. Following the recent advancements in computers and electronics, the use of a printed circuit board is the heart of this machine. It makes this machine dependable, accurate, and durable. It also gives the grower more flexible hours, reduces capital required, and will feed at least 50-60 calves.

What we have learned so far:

1. Calves are fed free choice mineral and therefore
   a. Calves eat less bedding
   b. Calves do less naval sucking
   c. Decrease tendency toward wood chewing
2. There are mild chemicals which can decrease the amount of ammonia.
3. Automatic timers can turn on a fogger system to control flies and parasites.
4. Calves are more readily identified by ear tags.
5. Feed intake can be monitored more closely by a counter that is on the machine.

I'm sure within the next few years, we will develop a good loose housing system that may supercede stall fed calves in many ways.

Because of prior experience of machine fed calves on bedding, I decided to use slatted floor pens in testing the Forster Technik machine. However, several groups of calves are now being fed in loose housing in bedded pens on this machine in the eastern U.S. and a few in the midwest.

Statistics from my first group are as follows:

1. Number of days on feed ------------------------ 98 days (14 wks)
2. Average market weight ----------------------- 331 lbs.
3. Average daily gain -------------------------- 2.25 lbs.
4. Feed conversion ---------------------------- 1.78
5. Death loss ---------------------------------- 9%
Calves were marketed 2 weeks earlier. Normal market weight, better average daily gain, normal feed conversion. Higher death loss was due to stress in shipment of calves purchased and also the abnormal hot summer heat. Dress out % is and will be lower. Grading and carcass score is very good. NOTE: There was a noted difference in the livers which weighed 15% less than normal in these calves. Even though free choice mineral supplement was fed, some wood chewing was noticed. Wood chewing was also noticed in previous groups on bedding and also in groups of weaned started calves where bedding — hay — grain and water is available at all times. Rumen bezoars (hair balls) seemed to be larger in comparison to either stall fed calves or loose housing fed calves on bedding.

In conclusion, animal welfare has been and will continue to be on the minds of everyone in this industry. It has taken many years of research and actual veal production to determine what the problems are and their possible solutions. The industry has met the challenges of proper health nutrition, a better degree of livability and calf quality. We can now attempt to find an alternate feeding and housing system. I am confident that in the 1980's this industry will find and adopt 1 or many loose housing systems. However, the extent of its use will depend upon how successful it is over the present system.

"At a time when everyone is being made aware of the welfare of all animals, the veal grower continues in his efforts to achieve and maintain the best possible environment for the calves in his facilities. He knows that the well-being of those calves is reflected in their health and development and, ultimately, in the degree of success — or failure — of the grower's operation."*

ANIMAL WELFARE COMMITTEE REPORT MINUTES

Chairman: E. Mickey Stewart, Lincoln, NE
Vice Chairman: Neal Black, St. Paul, MN

H. K. Anderson, MN; G. C. Cilley, NH; Oscar Clabaugh, KS; A. E. Decoteau, MA; B. H. Ewald, VA; M. W. Fox, DC; H. M. Frederick, VA; Robert Gadd, SD; Ann Gonnerman, MO; Carl Graham, MO; T. M. Gustafson, NE; Barbara Heffernan, DC; Michele C. Howard, CA; Donald Jones, KS; Kenneth Klingenberg, KS; R. J. Lee, VA; M. R. Levy, NJ; Arnett Matchett, MD; D. J. Meisinger, IA; Ronnie Polen, NJ; D. C. Randall, CO; R. A. Rice, NC; R. L. Rissler, MD; G. W. Roberts, CA; J. D. Roswurm, CA; D. F. Schwindaman, MD; M. S. Silberman, GA; Christine Stevens, DC; R. M. S. Temple, OH; Max Buskirk, PA; E. J. Wilson, MD

The Chairman called the meeting to order at 1:30 p.m. on Tuesday, October 18, 1983. He explained how the meeting would be conducted and asked that copies of any resolutions to be presented be given to the co-chairman. Each individual in the room was asked to introduce themselves. In addition to chairman E. Mickey Stewart, there were 22 committee members and 29 guests. Committee members present were: T. Gustafson, G. Cilley, M. Van Buskirk, Jr., R. Gadd, D. Schwindaman, C. Graham, B. Heffernan, F. Hasenauer, K. Klingenberg, D. Jones, J. Roswurm, R. Rissler, N. Black, M. Howard, R. Moody, O. Clabaugh, R. Rice, P. Kramer, G. Roberts, R. Lee, D. Meisinger, and R. Polen.

Dr. David Meisinger, committee member, gave an excellent report on his trip to England on behalf of the National Pork Producers Council to determine, first hand, what the farm animal welfare situation is in that country. His visits with people and organizations covered all aspects including the author of the book *Animal Factory*, a pig farmer, a representative of the United Federation of Animal Welfare, the Meat and Livestock Commission, The National Farmers Union, and a veterinarian with the British Ministry of Agriculture. Dr. Meisinger felt that his discussions were very beneficial, that most people were very objective, and that perhaps England was not as heavy on the animal welfare side of the scale as some reports would indicate.

The Committee was fortunate in having Dr. Ingvar Ekesbo from Sweden give an overview of the farm animal welfare situation in his country. As chairman of the Farm Animal Committee of the Council of Europe, which has 21 member states, he has been intimately involved in assuring that good scientific and practical information provide the basis for farm animal welfare codes which are adopted by the Parliaments of the member states. Dr. Ekesbo kindly agreed to send Chairman Stewart copies of information his committee has assembled on farm animal welfare in Europe.

Mr. Terry Seubert, a veal calf grower from Wisconsin gave a very good talk about the advantages and disadvantages of several housing methods for raising veal calves. The methods ranged from loose housing to indi-
individual stalls. Modifications of both types are still being constructed and evaluated. However, in his opinion, the individual stall design provides an efficient production system that is not detrimental to the welfare of the animals.

Ms. Diane Halverson, who was representing committee member Christine Stevens, gave a brief report on some research conducted in Europe to develop swine facilities which provide a practical mini environment based on the pigs behavioral patterns at different stages of their life. The housing and management principles are to be incorporated into a U.S. swine operation on a trial basis. She also read a report that Mrs. Stevens had prepared in support of Senate Bill 657 which would amend the Animal Welfare Act administered by USDA. The bill deals with the use of animals in biomedical research. She reported that the American Veterinary Medical Association also supports the bill.

Chairman Stewart then asked for any additional comments about the presentations or questions of the speakers. A short discussion followed.

There was discussion about next year's agenda — the ideas included having a representative of a laboratory that uses animals in research and a panel of behavioral scientists.

Since there were no resolutions presented nor old or new business, the meeting was adjourned at 4:15 p.m.
FOREIGN DISEASES AND ARTHROPOD PESTS OF LIVESTOCK AND POULTRY

Edwin I. Pilchard, DVM, PhD

and

Harless A. McDaniel, DVM, PhD

Principal Staff Officer for Scientific Resources, and

Chief Staff Officer

Technical Support Staff

Veterinary Services APHIS USDA

6505 Belcrest Road

Hyattsville, MD 20782

INTRODUCTION

Nearly 100 years ago the Bureau of Animal Industry (BAI) was established and began ridding the United States of contagious bovine pleuropneumonia. Since that time, 12 economically significant diseases and parasites of livestock and poultry have been eradicated and declared foreign to this country.\(^1\) Forty diseases were identified as foreign in 1972 by Veterinary Services (VS), Animal and Plant Health Inspection Service, one of the successor agencies to BAI in the U.S. Department of Agriculture. These were assigned different priorities for further developing capabilities for their exclusion or eradication.\(^2\)

This report lists 53 diseases and 32 arthropod pests of livestock and poultry considered foreign to the United States, presents steps that may be followed to maintain an up-to-date list, and ranks the diseases and arthropods by several different sets of priorities.

MEMBERS OF WORKING GROUP

The following served as appointed members of the general working group on foreign animal disease listing:

E. I. Pilchard, VS, General Chairperson, and H. A. McDaniel, VS, general member.

Subgroup on economic risks: D. F. Schwindamann, VS, and F. J. Alderink, VS.

Subgroup on vulnerability: J. A. Acree, VS, L. J. King, VS, W. W. Buisch, VS, H. J. Seyffert, VS, R. B. Caffey, Plant Protection and Quarantine (PPQ), and R. Ormiston, PPQ.

Subgroup on epidemiology: L. J. King, VS, R. A. Bram, Agricultural Research Service (ARS), and W. W. Buisch, VS.

Subgroup on availability of diagnostic procedures and reagents: J. A. House, ARS, G. A. Erickson, VS, and C. A. Mebus, ARS.


Subgroup on research needs: H. G. Purchase, ARS, D. D. King, ARS,
CRITERIA FOR ASSIGNING FOREIGN STATUS

A disease or arthropod pest of livestock or poultry is considered foreign if (1) it is not known to exist in the United States, and (2) if introduced, it will spread. A disease or arthropod should no longer be considered foreign if it is recognized by an agency of the Federal Government to exist in this country. Conversely, foreign status would be assigned if the Secretary of the U.S. Department of Agriculture declares it eradicated, or there is substantial supporting evidence it no longer exists here, or it is newly recognized in a foreign country.

The working group recommends these criteria be regularly applied to maintain an up-to-date list of foreign diseases and arthropod pests of livestock and poultry.

FOREIGN DISEASES

The following is an alphabetical list of livestock and poultry diseases foreign to the United States. These diseases are caused by biotypes or serotypes of agents or by defined agents that are not known to exist in this country.

African horsesickness, a highly fatal viscerotropic viral disease of equines, is caused by a virus of the genus orbivirus and transmitted by biting midges. The clinical forms of the disease are dominated by respiratory distress, colic, and pronounced swellings of the head and neck.3

African swine fever is caused by a virus of the genus Iridovirus and transmitted by direct contact, fomites, and Ornithodoros ticks. The subacute and chronic forms of the disease are characterized by pulmonary consolidation, fluid in body cavities, and inapparent carriers. The acute form of this disease is characterized by pronounced hemorrhage of internal organs, enlarged hemorrhagic spleen, marked reddening of skin and mortality of up to 100 percent of swine in affected herds.4

Akabane of cattle is caused by a virus of the genus Bunyavirus, and transmitted by biting midges and possibly mosquitoes. Fetal antibodies have suggested Akabane virus could be the cause of abortion, epidemic arthrogryposis, and hydranencephaly in fetuses and young cattle.5

Babesiosis, a febrile, tick-borne disease caused by sporozoan parasites of the genus Babesia, is characterized by extensive erythrocytic lysis leading to anemia, icterus, hemoglobinuria, and sometimes death.6

Bovine babesiosis is caused by Babesia bigemina, B. bovis, B. divergens, B. major, or B. species, transmitted by ticks of the genera Boophilus, Ixodes, and Rhipicephalus.

Porcine babesiosis is caused by B. trautmanni (Russia and Tanzania) and B. peroncitoi (Italy).

Ovine and caprine babesiosis are caused by B. motasi or B. ovis.

Bluetongue of sheep, cattle, and goats is caused by viruses of the genus
Orbivirus and transmitted by biting midges. Serotypes 1, 3 through 9, 12, 14 through 16, and 18 through 20 are exotic. Sheep are usually affected by fever with respiratory distress and congestion of the muzzle, lips, and ears. In severe cases, signs include a swollen, cyanotic tongue. Cattle may be inapparently affected or may have signs resembling those in sheep, including erosions of the muzzle, tongue, gingivae, and dental pad.

**Bovine petechial fever**, caused by the ricketttsia-like organism, *Ehrlichia ondiri*, suspected to be transmitted by arthropods, is characterized by decreased milk production in affected herds, petechial hemorrhages in the ventral surface of the tongue and in the vagina, and a course ranging from inapparent to fatal.

**Contagious agalactia** of sheep and goats, caused by *Mycoplasma agalactiae*, is characterized by acute mastitis, ophthalmitis, arthritis with painful swelling of affected joints, and abortion.

**Contagious equine metritis**, characterized by copious mucopurulent vaginal discharge in affected mares within a few days after breeding, is caused by bacteria tentatively named *Haemophilus equigenitalis*.

**Contagious bovine pleuropneumonia**, caused by *Mycoplasma mycoides mycoides*, is characterized by pneumonia, pleuritis, and classical “marbled” lung. Transmission is by discharges from the coughing of sick or recovered carriers. There is no known transmission to goats.

**Contagious caprine pleuropneumonia**, caused by *Mycoplasma mycoides capri*, is characterized by pneumonia and pleuritis, with variegated appearance of lung tissue due to the presence of different stages of hepatization and interlobular edema. There is no known transmission to cattle.

**Egg drop syndrome** of chickens is characterized by decreased rate of egg production in affected flocks, and caused by adenovirus 127 of the genus Aviadenovirus.

**Ephemeral fever** of cattle is caused by a virus of the family Rhabdoviridae, and transmitted by insect vectors, primarily biting midges. Fever, stiffness, lameness, and quick recovery characterize the disease.

**Encephalitis:**

Born, caused by an unclassified slow virus, is characterized by meningoencephalomyelitis, primarily of horses, sheep, and goats, manifested by ataxia and paralysis of the tongue. Of the two forms of the disease that have been recognized, the encephalitic form predominates over the myelitic.

Equine encephalosis, caused by a virus of the genus Orbivirus, has been described as an acute fatal disease manifested by excited behavior, incoordination, and fever.

Israel turkey meningoencephalitis, caused by a virus of the genus Flavivirus, is characterized by progressive paralysis and 10 to 20 percent mortality in affected flocks.
Japanese encephalitis, a mosquito-borne disease of swine, horses, and humans is caused by a virus of the genus Flavivirus, and characterized in piglets by tremors, ataxia, fever, and rapidly fatal course; stillbirths, mummified fetuses, and weak newborn piglets; and in horses by signs ranging from transient fever, anorexia, and jaundice, to incoordination, staggering and falling, and recovery in about 5 days. About 5 percent of affected horses develop high fever, demented or violent behavior, and die.

Louping ill, a nonfatal, tick-borne disease of sheep, caused by a virus of the genus Flavivirus is characterized by a peculiar leaping gait, impaired locomotion, and hyperexcitability. Hosts include cattle, horses, swine, and humans.

Teschen disease, a severe contagious encephalomyelitis of swine, caused by porcine enterovirus 1 of the genus Enterovirus, and characterized by ascending paralysis, progressing to flaccid paralysis.

Venezuelan equine encephalomyelitis of horses and humans caused by a mosquito-borne virus of the genus Alphavirus, is characterized in horses by lethargy, incoordination, braced stance, difficulty in swallowing, chewing movements, coma, and death.

Visna, a slowly progressive encephalomyelitis of adult sheep is caused by a virus of the subfamily Lentivirinae of the Family Retroviridae. Sheep affected by visna are nearly always found to be affected by Maedi.

Foot-and-mouth disease of cloven-hoofed animals is caused by viruses of the genus Aphthovirus and characterized by fever, and vesicles in the mouth, nose, feet, and teats.

Fowl plague (chicken-lethal influenza), is a highly fatal generalized disease of chickens, caused by a virus of the genus Influenzavirus.

Getah of horses, characterized by lameness and swelling of the lower legs, is caused by a virus tentatively classified in the genus Alphavirus. The virus is suspected to be arthropod-borne by mosquitoes, including Aedes vexans and Culex tritaeniorhynchus.

Glanders of horses, and occasionally humans and cats, is characterized by rhinitis, coughing, nosebleeding, and skin ulcers, caused by Pseudomonas mallei.

Goat pox and sheep pox, are caused by antigenically distinct viruses of the genus Capripoxvirus, and characterized by papules, vesicles, and pustules on exposed body surfaces, often with a high mortality rate.

Goose hepatitis, caused by a virus of the genus Parvovirus is characterized by watery white diarrhea, runting, locomotor abnormalities, nasal and ocular discharge, and high mortality rate in goslings.

Heartwater of sheep, goats, and cattle, characterized by copious fluid in the pericardial sac, is caused by Cowdria ruminantium, and transmitted by Amblyomma ticks. In the acute form of the disease, signs may resemble strychnine poisoning or tetanus.

Hemorrhagic septicemia (Asiatic), a highly fatal disease of cattle and buffalo, characterized by hemorrhages in many parts of the body and edematous swellings in the throat and neck, is caused by virulent strains of Pasteurella multocida.
**Hog cholera**, is caused by a virus of the genus Pestivirus. Highly contagious to swine of all ages, the acute form of this disease is characterized by sudden onset, high mortality and morbidity, and signs including high fever, muscular weakness, cyanosis of the skin, and occasionally, convulsions. Strains of the virus of low virulence cause subacute and chronic forms of the disease that include complications of pneumonia and diarrhea.

**Ibaraki** of cattle, an acute febrile disease characterized by superficial erosions of mucous membranes, swallowing difficulty, dehydration, emaciation, and death is caused by an insect-borne virus of the genus Orbivirus, which is classified with epizootic hemorrhagic disease of deer.

**Lumpy skin disease**, an acute, highly infectious viral disease of cattle, characterized by the eruption of cutaneous nodules, edema of limbs, and swelling of superficial lymph nodes, is caused by Neethling virus of the genus Capripoxvirus.

**Maedi**, a chronic progressive pneumonia of sheep, in which the weight of the lungs and bronchial lymph nodes may increase three-to fourfold, with marked loss of body weight, is caused by a virus of the subfamily Lentivirinae, family Retroviridae, identical to Visna virus.

**Melioidosis** of swine, sheep, goats, cattle, horses, certain wildlife, and humans, characterized by caseous nodules and abscesses in the lymph nodes and viscera, is caused by *Pseudomonas pseudomallei*. The disease signs vary from an acute, fatal pneumonia and septicemia, to a variety of signs, including polyarthritis, locomotor dysfunction, cutaneous abscesses, emaciation, and death.

**Nairobi sheep disease** of sheep and goats, caused by a virus of the genus Nairovirus, and transmitted by ixodid ticks, is characterized by an acute gastroenteritis, respiratory distress, and mucoid nasal discharge. Affected ewes may abort.

**Nematodiasis** of sheep, caused by *Nematodirus battus*, is characterized by profuse diarrhea and marked dehydration, and death of lambs 6- to 12-weeks old.

**Parafilariasis** of cattle, caused by *Parafilaria bovicola*, is characterized by small bleeding perforations in the skin of the neck and back, which usually occur in the early spring or later in cattle that were exposed to vector flies, *Musca* spp., during the preceding pasture season.

**Peste des petits ruminants** in sheep and goats resembles rinderpest of cattle and is caused by a virus of the genus Morbillivirus closely related to the virus of rinderpest.

**Rift Valley fever** of cattle, sheep, and humans, caused by an arthropod-borne virus of the genus Phlebovirus, is characterized by high rates of abortion in sheep and cattle, and high rates of mortality in young lambs and calves.

**Rinderpest** of cattle, buffalo, other ruminants, and, occasionally, swine, caused by a virus of the genus Morbillivirus, is characterized by
watery, frequently bloody diarrhea, necrosis of the alimentary lining, and “punched-out” erosions of the digestive tract.3

**Schistosomiasis** of ruminants, caused by *Schistosoma bovis, S. mattheei, S. spindale, S. japonicum,* and *S. indicum,* is characterized by signs ranging from loss of body weight to severe diarrhea, anemia, and hematuria.26

**Nasal schistosomiasis** of cattle, horses, and buffaloes, is caused by *Schistosoma nasalis,* characterized by lesions in the nasal cavity but not in the internal organs.27

**Swine vesicular disease,** is caused by a virus identical with Cox sackievirus B5, and characterized by fever, and lameness due to vesicles and erosions on the feet.3,28

**Theileriasis** of cattle caused by *Theileria parva,* the tick-borne protozoal agent of *east coast fever,* is characterized by swelling of the lymph nodes, emaciation, and high rate of mortality. *T. lawrencei,* the agent of *corridor disease,* causes signs similar to those of *east coast fever.*3,29

**Tick-borne fever** of cattle, sheep, and goats caused by *Rickettsia phagocytophilia,* transmitted by *Ixodes ricinus* (Great Britain) and *Rhipicephalus haemaphysaloides* (India), is characterized by fever, abortion, muscular stiffness and lameness, loss of body weight, and low rate of mortality.20,30

**Trypanosomiasis** — **African trypanosomiasis** (Nagana) of cattle, caused by *Trypanosoma congoense, T. simiae, T. brucei,* and *T. vivax,* which are transmitted primarily by tsetse flies, is characterized by chronic loss of body weight and anemia.3 *Surra,* the African trypanosomiasis of horses, cattle, and camels, caused by *Trypanosoma evansi,* is characterized by anemia and intermittent fever.3 *Dourine* of horses, caused by *Trypanosoma equiperdum,* is characterized by veneral transmission, edema of the limbs and ventral surface of the abdomen, enlargement of lymph nodes, sometimes lameness, and abortion.31

**Velogenic viscerotropic Newcastle disease,** a highly contagious, lethal viral disease of chickens, turkeys, and various other birds, is characterized in chickens by respiratory distress, edema of the head around the eyes, and hemorrhages in lymphoid tissues and intestinal wall, and caused by a virus of the genus Paramyxovirus.32

**Vesicular exanthema** of swine, caused by a virus of the genus Calicivirus, is characterized by vesicles on the snout, in the mouth, and on the feet.33

**Vesicular stomatitis** of cattle, horses, swine, and humans, caused by exotic serotypes of the causative Rhabdovirus, is characterized by fever and vesicular lesions similar to those of foot-and-mouth disease in cattle.34 Indiana type 1 and the New Jersey type of vesicular stomatitis occur in the United States.

**Wesselsbron** of sheep, cattle, horses, and humans, caused by a mosquito-borne virus of the genus Flavivirus, is characterized in sheep by
abortion and high mortality in lambs.  

**Jembrana disease** of water buffalo and Balinese cattle is mentioned provisionally as a foreign disease, even though it has not been characterized completely, because it has been reported as the cause of major "rinderpest-like" death losses in Bali. It is thought to be caused by an unidentified virus, possible transmitted by arthropods, including the tropical cattle fever tick, *Boophilus microplus*.

**FOREIGN VIRUSES OF SPECIAL INTEREST**

Several arthropod-borne viruses isolated for livestock and poultry, have been reported in the literature without a description of associated, natural disease. Experimental inoculations have in some instances produced disease not identified with the natural history of the virus. Some of these of special interest are listed in Table 1.

<table>
<thead>
<tr>
<th>Virus</th>
<th>Isolated From</th>
<th>Transmitted By</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absettarov</td>
<td>Goats</td>
<td>Ticks</td>
</tr>
<tr>
<td>Banzí</td>
<td>Cattle and sheep</td>
<td>Mosquitoes</td>
</tr>
<tr>
<td>Middleburg</td>
<td>Sheep, goats, and cattle</td>
<td>Mosquitoes</td>
</tr>
<tr>
<td>Murray Valley</td>
<td>Cattle, horses, dogs, and fowl</td>
<td>Mosquitoes</td>
</tr>
<tr>
<td>Negishi</td>
<td>Goats</td>
<td>Possible arthropod</td>
</tr>
<tr>
<td>Sagiyama*</td>
<td>Swine and horses</td>
<td>Mosquitoes</td>
</tr>
</tbody>
</table>

* Considered to be a subtype of Getah virus.

**RANKING OF FOREIGN DISEASES**

Subgroups of the general working group on foreign animal disease listing have ranked the diseases independently according the following sets of ranking criteria:

**Economic risks**
- Direct losses and costs
- Increased cost of production
- Indirect costs
- Number of species and number of animals affected

**Vulnerability**
- Present distribution
- Agent resistance
- Transmission
- Vectors
- Vector efficiency
- Host, reservoirs — likelihood of introduction

**Epidemiological risks**
- Agent factors
Host factors
Vector factors
Miscellaneous factors including vaccine availability, and the availability of knowledge concerning the disease, its prevention and control.

Availability of tests and reagents
Availability of a diagnostic test or tests
Adequacy of test to rapidly identify the disease
Availability of test reagent(s)

Research needs
Need for information for action agency programs
Fit with research agency mission
Need for basic knowledge
Current level of U.S. research
Current level of world research

The members of respective subgroups scored each disease numerically for each ranking criterion in the assigned category, using a range of 0 (low) to 4 (high). Double weight was given to vectors and vector efficiency under vulnerability, and to vector factors and certain agent factors under epidemiological risks. An average score was then calculated for each disease, by each set of ranking criteria. When the diseases were ranked by their average scores, some of them were found to have equal rank, e.g. Rift Valley fever and foreign types of bluetongue were considered of equal epidemiological risk.

Table 2 shows the foreign diseases that are considered economically significant, ranked in descending orders of priority for economic risks; vulnerability to their introduction, establishment and spread; risk of transmission and persistence; risk due to unavailability of practical diagnostic tests and test reagents; and need for research.
**Table 2. Foreign Diseases Ranked In Categories**

<table>
<thead>
<tr>
<th>Disease</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot-and-mouth disease</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Rinderpest</td>
<td>2</td>
<td>13</td>
<td>15</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Rift Valley fever</td>
<td>3</td>
<td>11</td>
<td>2</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Contagious bovine pleuropneumonia</td>
<td>4</td>
<td>12</td>
<td>13</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Parafilariasis</td>
<td>5</td>
<td>16</td>
<td>6</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Lumpy skin disease (Neethling virus)</td>
<td>6</td>
<td>5</td>
<td>11</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>Exotic Newcastle disease</td>
<td>7</td>
<td>2</td>
<td>8</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Ibaraki</td>
<td>8</td>
<td>22</td>
<td>5</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Hog cholera</td>
<td>9</td>
<td>1</td>
<td>10</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Bluetongue (foreign types)</td>
<td>10</td>
<td>17</td>
<td>2</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>African trypanosomiasis</td>
<td>11</td>
<td>19</td>
<td>8</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>African swine fever</td>
<td>12</td>
<td>15</td>
<td>1</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Venezuelan equine encephalomyelitis</td>
<td>13</td>
<td>18</td>
<td>6</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Vesicular stomatitis (foreign types)</td>
<td>14</td>
<td>NR</td>
<td>8</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>East coast fever</td>
<td>15</td>
<td>24</td>
<td>7</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Melioidosis</td>
<td>16</td>
<td>10</td>
<td>16</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>Bovine babesiosis</td>
<td>17</td>
<td>9</td>
<td>8</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Swine vesicular disease</td>
<td>18</td>
<td>4</td>
<td>11</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Contagious equine metritis</td>
<td>19</td>
<td>8</td>
<td>20</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>African horsesickness</td>
<td>20</td>
<td>23</td>
<td>3</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Borna</td>
<td>21</td>
<td>7</td>
<td>14</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Glanders</td>
<td>22</td>
<td>6</td>
<td>16</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Ephemeral fever</td>
<td>23</td>
<td>21</td>
<td>10</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Japanese encephalitis</td>
<td>24</td>
<td>14</td>
<td>8</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Heartwater</td>
<td>25</td>
<td>20</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>

NR = not ranked

* Categories: A, economic risks; B, vulnerability; C, epidemiological risks; D, availability of tests and reagents; E, research needs

** Criteria are given under "Ranking of foreign diseases."

### RANKING OF FOREIGN ARTHROPODS

Foreign arthropod species and genera affecting livestock are listed in Table 3, in the order of their importance, as judged by the following criteria.

- Potential for introduction
- Potential for establishment
- Economic impact
- Ability to transmit disease or cause myiasis

Members of the working subgroup on foreign arthropod pests of livestock scored each species and genus, using a range of 0 (low) to 4 (high). An average score was then calculated to each species or genus. When ranked by their average scores, some of them were found to have equal rank, e.g. cattle tick and brown ear tick.
<table>
<thead>
<tr>
<th>Rank</th>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Category A—highest potential for introduction, establishment, and economic impact)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Screwworm</td>
<td>Cochliomyia hominivorax</td>
</tr>
<tr>
<td></td>
<td>Sheep scab mite</td>
<td>Psoroptes ovis</td>
</tr>
<tr>
<td></td>
<td>Tropical bont tick</td>
<td>Amblyomma variegatum</td>
</tr>
<tr>
<td></td>
<td>Southern cattle tick</td>
<td>Boophilus microplus</td>
</tr>
<tr>
<td>2</td>
<td>Cattle tick</td>
<td>Boophilus annulatus</td>
</tr>
<tr>
<td></td>
<td>Brown ear tick</td>
<td>Rhipicephalus appendiculatus</td>
</tr>
<tr>
<td>3</td>
<td>Torsalo</td>
<td>Dermatobia hominis</td>
</tr>
<tr>
<td>4</td>
<td>Old world screwworm</td>
<td>Chrysomyia bezziana</td>
</tr>
<tr>
<td></td>
<td>(Category B—of particular concern)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Hard ticks</td>
<td>Hyalomma spp.</td>
</tr>
<tr>
<td>6</td>
<td>Tsetse flies</td>
<td>Glossina spp</td>
</tr>
<tr>
<td>7</td>
<td>Muscoid flies</td>
<td>Musca supp</td>
</tr>
<tr>
<td></td>
<td>Mosquitoes</td>
<td>Anopheles spp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Culex spp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aedes spp</td>
</tr>
<tr>
<td>8</td>
<td>Hard ticks</td>
<td>Amblyomma spp</td>
</tr>
<tr>
<td>9</td>
<td>Hard ticks</td>
<td>Dermacentor spp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ixodes spp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rhipicephalus spp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hippobosca spp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ornithodoros spp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Argas spp</td>
</tr>
<tr>
<td>10</td>
<td>Hard ticks</td>
<td>Haemaphysalis spp</td>
</tr>
<tr>
<td></td>
<td>(Category C—some potential for introduction, establishment, and economic impact)</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Muscid flies</td>
<td>Muscidae</td>
</tr>
<tr>
<td>12</td>
<td>Mosquitoes</td>
<td>Culicidae</td>
</tr>
<tr>
<td>13</td>
<td>Biting midges</td>
<td>Ceratopogondidae</td>
</tr>
<tr>
<td>14</td>
<td>Horse flies</td>
<td>Tabanidae</td>
</tr>
<tr>
<td>15</td>
<td>Black flies</td>
<td>Simuliidae</td>
</tr>
<tr>
<td>16</td>
<td>Africanized honeybees</td>
<td>Apis</td>
</tr>
<tr>
<td></td>
<td>Bot flies</td>
<td>Oestridae</td>
</tr>
<tr>
<td></td>
<td>Robust bot flies</td>
<td>Cuterebridae</td>
</tr>
<tr>
<td></td>
<td>Flesh flies</td>
<td>Sarcophagidae</td>
</tr>
<tr>
<td>16</td>
<td>Eye gnats</td>
<td>Chloropidae</td>
</tr>
</tbody>
</table>
SUMMARY

Fifty three (53) diseases and 32 arthropod pests of livestock and poultry, foreign to the United States were identified by a working group in the U.S. Department of Agriculture, with criteria that may be used to maintain an up-to-date listing. The diseases were then ranked by their relative importance, according to the following sets of criteria: (1) economic risks, (2) vulnerability, (3) epidemiology, (4) availability of tests and reagents, and (5) research needs. The arthropods were ranked by their potential for introduction and establishment in the United States, economic impact, and ability to transmit disease or cause myiasis.

Members of the working group freely acknowledge the subjective nature of their listing and priority ranking efforts, while commending the results as a guide or point of departure for program planners, research organizations, action agencies, and others with an interest in protecting American livestock and poultry. Any foreign disease or arthropod pest that is found in U.S. livestock or poultry would, of course, be given first priority for control and eradication actions.

REFERENCES


Mr. Chairman, members and guests:

The Epizootic Attack Committee was convened at 1:30 p.m. October 20, 1983 in room 10 by Joe Finley. Over 50 members and guests were present.

A review of Emergency Programs stimulated an interesting and informative discussion. Several members thought there was a need for better organization and education at the state level for foreign animal disease surveillance.

Jack Dahl presented an excellent talk on Animal Health issues in the United States and related many of the activities and interests of both the Secretarly's Advisory Committee and the National Academy of Science's National Research Council Committee to this committee. He requests this committee's concurrence on a resolution already passed by the Import-Export committee to improve and strengthen the Secretaries committee on foreign animal disease.

Manuel Garza E gave a very enlightening presentation on Animal Health Issues in Mexico which highlighted the Mexican tick eradication program. He was optimistic about the eradication of Boophilus ticks from Mexico, but believed it would be several years before the last ticks would be killed.

E. I. Pilchard presented a revised listing of foreign diseases and arthropods of livestock and poultry. A USDA study group from both ARS and APHIS worked long and hard to develop this listing.

Emil Dolensek provided background information relative to a request for approval of St. Catherine's Island as a Permanent Postentry Quarantine (PPQ) facility for zoological animals. A vigorous and prolonged discussion followed. Concern was expressed for discrepancies between laws and regulations for importing zoological animals and livestock. Two resolutions were passed asking a study of the entire matter and a moratorium on approval of additional PPQ zoological facilities pending outcome of the study.

The committee meeting adjourned at approximately 5:15 p.m.
INTRODUCTION

It has been well documented that within the food and kindred products industry, meatpacking ranks highest in terms of daily pollutional discharge, and in comparison to other agriculturally based industries, is second only to pulp and paper production (1, 2). Since there are several thousand meatpacking operations distributed across every state in the U.S., and since there are only a few hundred pulp and paper mills located in about half the states, meatpacking could be considered the most pervasive, if not the most significant agriculturally related industry in the U.S. (2).

Meatpacking wastes are similar to domestic sewage in that both are biodegradable, contain similar types of compounds, have inherent organisms necessary for biological decomposition, and respond to the same treatment processes; however, the significantly higher concentrations of virtually all constituents in meatpacking wastes result in a wastewater that is difficult to treat to levels acceptable to discharge.

The difficulty in treatment and the potential of meatpacking wastes as a source of pollution is evident from Table 1 which compares a typical packinghouse wastewater to a typical community sewage. This can be further illustrated in terms of population equivalents. For example, a small packinghouse processing 100 animals per work day at an average weight of 800 pounds per animal, would generate a biochemical oxygen demand (BOD) equivalent to a community of 5,700. For larger meatpacking operations, the population equivalent would increase proportionally; consequently, a single packinghouse could generate a pollutional load higher than the entire adjacent community.

Historically, many meatpacking wastes have been discharged with insufficient treatment directly into the environment, and in many other instances, such wastes, with little or no pretreatment, have been discharged into community sewage treatment plants which were not able to accommodate such wastes and still comply with their discharge limitations. In both cases, the pollutants from the meatpacking operation are passed into the environmental waters. It is understandable then, that regulatory agencies have addressed considerable attention to the treatment of meatpacking wastes.

REGULATORY BACKGROUND

The Clean Water Act of 1972 (PL 92-500) delegated the responsibility for developing effluent guidelines to EPA, which in 1974 first published the
TABLE 1

COMPARISON OF A TYPICAL PACKINGHOUSE WASTEWATER WITH A TYPICAL COMMUNITY SEWAGE

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Concentration, mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Packinghouse Effluent (3)</td>
</tr>
<tr>
<td>BOD</td>
<td>1387</td>
</tr>
<tr>
<td>TSS</td>
<td>997</td>
</tr>
<tr>
<td>O &amp; G</td>
<td>688</td>
</tr>
<tr>
<td>Flow (gal./1000 lbs. LWK)</td>
<td>1046</td>
</tr>
<tr>
<td>Flow (gal./cap/day)</td>
<td></td>
</tr>
</tbody>
</table>

standards for meatpacking (4). These limits, which were to apply to facilities discharging directly to the environment, were to be enforced at the state level through the federally required NPDES permit. As shown in Table 2, the limits designated as “best practical treatment” (BPT) went into effect July 1, 1977, and those identified as “best available treatment” (BAT) were originally scheduled for July 1, 1983, but have been delayed by litigation. By comparison with the values for a packinghouse effluent, the magnitude of the treatment problem becomes obvious.

TABLE 2

EPA DISCHARGE GUIDELINES AND TYPICAL PACKINGHOUSE EFFLUENT LEVELS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>EPA Limits</th>
<th>Typical Packaging</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BPT</td>
<td>BAT</td>
</tr>
<tr>
<td>BOD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-day average</td>
<td>0.17</td>
<td>0.04</td>
</tr>
<tr>
<td>1-day maximum</td>
<td>0.34</td>
<td>0.08</td>
</tr>
<tr>
<td>TSS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-day average</td>
<td>0.24</td>
<td>0.06</td>
</tr>
<tr>
<td>1-day maximum</td>
<td>0.48</td>
<td>0.12</td>
</tr>
<tr>
<td>O &amp; G</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-day average</td>
<td>0.06</td>
<td>—</td>
</tr>
<tr>
<td>1-day maximum</td>
<td>0.12</td>
<td></td>
</tr>
</tbody>
</table>

For meatpackers discharging into community sewage treatment plants, EPA has not yet developed specific pretreatment standards, and until such occurs, local ordinances prevail. As these local ordinances are periodically updated in order to assist the community sewage treatment plant in
complying with its discharge limitations, meatpackers are facing not only the necessity to pretreat in order to be allowed to discharge, but also increased surcharges and/or user fees once the wastes are accepted into the community sewerage system.

Illustrating this using Oklahoma as an example, the NPDES program is administered by the Water Resources Board whose limits applicable to meatpackers with direct discharge, are listed in Table 3. Also shown in this table are the levels at which Oklahoma City initiates a surcharge above the standard user charge, and the levels at which the City may prohibit discharge to its sewers. From this, it may be seen that for a packinghouse to be permitted for direct discharge in Oklahoma, treatment efficiencies approximating 97 percent for BOD, 95 percent for total suspended solids (TSS), and 98 percent for oil and grease (O & G), would be required.

**TABLE 3**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>State of Oklahoma</th>
<th>Oklahoma City Surcharge</th>
<th>Prohibited</th>
<th>Typical Packinghouse</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD</td>
<td>40</td>
<td>250&lt;sup&gt;a&lt;/sup&gt;</td>
<td>750</td>
<td>1387</td>
</tr>
<tr>
<td>TSS</td>
<td>45</td>
<td>300&lt;sup&gt;b&lt;/sup&gt;</td>
<td>750</td>
<td>997</td>
</tr>
<tr>
<td>O &amp; G</td>
<td>15</td>
<td>—</td>
<td>200</td>
<td>688</td>
</tr>
</tbody>
</table>

<sup>a</sup> $0.62/MG/mg/L for effluent levels over indicated value  
<sup>b</sup> $0.36/MG/mg/L for effluent levels over indicated value

For a packinghouse discharging into an Oklahoma City sewer, pretreatment efficiencies of at least 82 percent for BOD and 70 percent for TSS would be required to avoid the additional surcharges. If the wastes were pretreated just to the prohibited discharge level, then the small packinghouse described above would be faced with a monthly surcharge of $571 for BOD and $298 for TSS. This total of $869 would be in addition to the normal sewer fee and in addition to pretreatment costs. In view of the ever advancing water quality standards on-site treatment of meatpacking wastes is becoming an economic, if not legal, necessity.

**EFFLUENT UPGRADEING**

*Process evaluation.* The standard stepwise approach to industrial pollution abatement is presented in Table 4. Applying the first step, process evaluation, to a typical packinghouse, results in the flow diagram illustrated in Figure 1. This, along with the determination of the volume and character of flow from the various unit operations, provides the background for addressing the problem. For example, it may be found that the kill floor furnishes almost half the total flow from the plant but only 10
TABLE 4
INDUSTRIAL POLLUTION ABATEMENT PROCEDURE

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Survey unit operations and obtain data regarding flow and character of wastewater from each.</td>
</tr>
<tr>
<td>II.</td>
<td>Analyze applicable in-plant modifications to reduce volume and strength of flow to be treated.</td>
</tr>
<tr>
<td>III.</td>
<td>Determine wastewater treatment necessary to meet various disposal options.</td>
</tr>
</tbody>
</table>

to 15 percent of the oxygen demand, with the largest portion of the flow originating with the carcass washers, and the majority of the oxygen demand coming from the carcass and tripe washers. The production of finished meat products may produce 15 to 20 percent of the flow but only 3 to 4 percent of the oxygen demand. On the other hand, the rendering process may contribute only 5 percent of the flow but almost 70 percent of the oxygen demand. Plantwide clean-up may contribute 30 percent of the flow representing 16 percent of the oxygen demand. This type of information is needed in order to intelligently apply the in-plant modifications outlined in Table 5.

TABLE 5
IN-PLANT MODIFICATIONS FOR REDUCTION OF WASTEWATER VOLUME AND STRENGTH

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Water Conservation/Flow Reduction</td>
</tr>
<tr>
<td>II.</td>
<td>Solids and Byproduct Recovery</td>
</tr>
<tr>
<td>III.</td>
<td>Segregation of Waste Streams</td>
</tr>
<tr>
<td>IV.</td>
<td>Solids Separation</td>
</tr>
</tbody>
</table>

*In-plant modifications (5).* From the standpoint of cost/benefit ratio, water conservation/flow reduction is the most effective pollution abatement procedure applicable to meatpacking because installation and maintenance costs are comparatively low while the reduction in the volume of wastes transported and treated, and the volume of tap water purchased, provide continuous savings. Application of the principles outlined in Table 6 has been effective in achieving flow reductions of 75 percent (5).

The second in-plant modification listed in Table 7 is solids and byproduct recovery, which also provides dual benefits in that the volume and strength of the wastewater can be reduced and potentially marketable products produced. Examples include blood, which has the highest BOD of any fluid produced by meatpacking operations; paunch manure, which also has high BOD and TSS contributions if it is “wet dumped;” holding pen wastes, which can add significantly to the BOD and TSS if the pens are wet cleaned without preliminary scraping and if they are not covered in high rainfall areas; and meat bits and bone dust, which can represent
Figure 1. Typical packinghouse unit operations
TABLE 6
PRINCIPLES OF WATER CONSERVATION/FLOW REDUCTION

I. Wherever feasible, keep solid wastes in bulk form rather than flushing to the sewer.

II. For washing product, use minimum water pressure and volume consistent with acceptable quality.

III. For cleaning, use high pressure and low volume water delivery systems.

IV. Where possible use demand activated, automatic shut-off valves.

V. Within USDA limits, recycle water where feasible.

Table 6 continues...

TABLE 7
IN-PLANT MODIFICATIONS FOR REDUCTION OF WASTEWATER VOLUME AND STRENGTH

I. Water Conservation/Flow Reduction

II. Solid and Byproduct Recovery
   Blood and Hair
   Paunch Manure
   Holding Pen Manure
   Meat Bits and Bone Dust

III. Segregation of Waste Streams

IV. Solids Separation

Table 7 continues...

Separately. Sanitary drainage is low strength and easily handled compared to the process wastes and should be collected and discharged directly to the sanitary sewer or to separate sewage treatment. Finally, clear waters from sources such as cooling and condensing are suitable for recycling or other reuse and should not be mixed with other flows.

The final in-plant modification mentioned involves separation of solids (Table 9). Once the above modifications have been exercised to their optimal endpoint, the application of solids separating processes appropriate for the nature of the solids remaining in each waste stream can markedly reduce the TSS, O & G, and BOD to be handled by subsequent treatment. For example, the Hydrasieve has been applied to paunch manure slurry, hog hair recovery, and hide processing wastes, and has demonstrated solids removal efficiencies of 60 percent (5). Due to the high...
initial and operating costs, centrifuges are not in widespread use in the
meatpacking industry; however, as water quality standards advance, the
need to increase the removal of grease and fine solids may expand their
application.

Gravity catch basins can be used to lower the concentration of both
grease and suspended solids. Removal efficiencies range from 50 to 60
percent for O & G, 40 to 50 percent for TSS, and 20 to 30 percent for BOD
(5). Diffused air floatation (DAF) is exceptionally applicable to grease re-
moval but will also effect a reduction in suspended solids. DAF units can
remove at least 80 percent of the grease when applied alone or over 90
percent when used in conjunction with gravity separation (5).

_Treatment Options_ (3). Even though the application of in-plant modi-
fications may reduce the flow by as much as 75 percent, the BOD by 50
percent, the TSS by 70 percent, and the O & G by 80 percent, the waste-
water may still require additional treatment, in order to meet sewer
discharge limits especially for BOD and TSS. For direct discharge, ad-
ditional treatment would be a certainty. Some of the various treatment
processes that have been applied to meatpacking wastes, are shown in
Table 10.

### TABLE 9

<table>
<thead>
<tr>
<th>Water Conservation/Flow Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids and Byproduct Recovery</td>
</tr>
<tr>
<td>Segregation of Waste Streams</td>
</tr>
<tr>
<td>Blood</td>
</tr>
<tr>
<td>Sanitary Drainage</td>
</tr>
<tr>
<td>Manure</td>
</tr>
<tr>
<td>Clear Water</td>
</tr>
<tr>
<td>Grease</td>
</tr>
<tr>
<td>Solids Separation</td>
</tr>
</tbody>
</table>

_STATIC, VIBRATING, ROTARY SCREENS_
As adapted for the treatment of meatpacking wastes, anaerobic lagoons are designed with depths of 12 to 17 ft and have loading rates of 15 to 20 lbs BOD/1000 ft$^3$/day. Since anaerobic decomposition under these conditions produces odor problems, covers and a remote location are both highly advisable. Additionally, the pond effluent is not suitable for discharge without further treatment by another process such as an aerobic lagoon. Overall, this process is compatible with the technical and economic constraints of a small packinghouse.

Aerobic lagoons may be of two types, those that are mechanically aerated (aerated lagoons) and those that use phytoplankton respiration as the oxygen source (facultative lagoons). The former may be designed with depths up to 15 ft and may have detention times as long as 10 days. Even though they require less space than their facultative counterpart, additional treatment may still be necessary, especially if such ponds are used as the initial treatment.

Facultative ponds are designed with depths up to 5 ft, detention times up to 4 months and loading rates of 20 to 40 lbs BOD/acre/day. Such loading rates require some type of preceding treatment, and the high levels of phytoplankton in the effluent will, in all probability, result in BOD and TSS levels that exceed discharge limits unless further treatment is applied. In general, both types of aerobic ponds are suitable for the small packinghouse.

Numerous modifications of the activated sludge process are amenable to the treatment of meatpacking wastes, but all require preceding treatment. Such facilities are relatively compact, but construction, operation, and maintenance costs are high, as is the level of operator skill required. These factors generally restrict the application of conventional activated sludge processes to the larger packinghouses.

Trickling filters are also applicable to the treatment of meatpacking wastes but they may require some type of additional treatment which may precede and/or follow the filter. Such treatment is more compact than the ponds but less so than the activated sludge processes. They are also
intermediate in construction, operation and maintenance costs, and operator skill, but high in hydraulic head requirements. Rotating biological contractors (RBCs) are generically the same type of treatment as trickling filters and have the same general advantage and limitations. Their design eliminates the high hydraulic head loss of the trickling filters, but this is offset by the necessity of enclosing the disks within a structure. Neither the trickling filter nor the rotating biological contractor are considered readily adaptable to small packinghouses, especially those operating less than three shifts per day.

Channel aeration (6) is a process akin to both activated sludge and aerated lagoons. With detention times of 1 to 3 days, space requirements are second only to the pond processes, and pre- and post-treatment may be required to meet the limits for direct discharge. Overall, this treatment procedure is not highly compatible with the technical and economic constraints of a small packinghouse.

Sand filtration (7) as applied here involves the intermittent application of wastewater to a filter constructed to 2 to 3 ft of 0.2 to 0.50 mm diameter sand overlying 12 to 15 inches of gravel covering an underdrain system. At an application rate of 0.5 mgd or less, sand filters can produce an effluent that meets present direct discharge requirements but pretreatment is required. Space requirements are less than for the pond processes, but like the ponds, the capital and operating costs of the sand filters are consistent with the limitations of the small packinghouse.

Land application can be by spray irrigation, overland flow (7,8) or rapid infiltration, depending on soil type and slope. In addition to the comparatively large space required for application, all three methods require pretreatment of the wastewater plus a facility for holding the flow during periods when the wastewater cannot be applied. Spray irrigation and rapid infiltration have the potential for groundwater contamination; however, both spray irrigation and overland flow could be employed for the production of a marketable crop. The high salt content of a typical packinghouse wastewater results in a high sodium absorption ratio that must be considered in spray irrigation and overland flow. Overall, the effluent levels of BOD, TSS, and O & G achievable by land application are within direct discharge limits and the technical and economic considerations should be acceptable to small packinghouses with available land.

The use of chemical flocculating agents such as aluminum sulfate and ferric chloride can reduce BOD and TSS with efficiencies comparable to those achievable by DAF (9); however, proprietary chemical processes can be effective in lowering the BOD, TSS, and O & G to a level suitable for discharge to a community sewer, with only nominal, if any, surcharge (2,9). Direct discharge would require subsequent treatment by one or more of the processes described above. Even though the trade-name processes do offer the advantage of recovery of a marketable product to help defray treatment costs, this benefit may not be sufficient to override the technical and financial limitation of a small packinghouse.
Selection of Treatment Options. It is obvious from the wide range of available treatment processes that no one single process or sequence of processes is best for all packinghouses. Local factors such as those listed in Table 11 determine the optimal choice.

### TABLE 11
FACTORS INFLUENCING THE SELECTION OF A TREATMENT PROCESS

<table>
<thead>
<tr>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of the plant</td>
</tr>
<tr>
<td>Operational schedule</td>
</tr>
<tr>
<td>Managerial philosophy and priorities</td>
</tr>
<tr>
<td>Byproduct market</td>
</tr>
<tr>
<td>Discharge limitations</td>
</tr>
<tr>
<td>Costs (construction, operation, maintenance)</td>
</tr>
<tr>
<td>Technical constraints (operator skill)</td>
</tr>
</tbody>
</table>

Small packinghouses do, however, have limitations (Table 12) that greatly restrict the feasible alternatives. It might appear from this list of constraints, and the foregoing discussion of wastewater characteristics and treatment options, that the ideal treatment sequence does not exist for small packinghouses especially for those that do not operate but one or two shifts per day. This may be true; however, there are some viable options that can permit such a facility to achieve effluent limits for discharge to a community sewer or, as the case may be, to comply with the current limits for direct discharge. The recommended treatment would be batch-type extended aeration for discharge to a community sewer, or for direct discharge, land application, aerated lagoon, or intermittent sand filtration could be added.
To illustrate this (Table 13) using the above mentioned small packinghouse that processes 100 animals per working day, the anticipated flow at 1046 gal/1000 lbs. LWK, would be 83,690 gal/day at an anticipated BOD of 1387 mg/l, a TSS of 997 mg/L, and an O & G of 688 mg/L. Assuming in-plant modifications would reduce the flow by 35 percent to 54,392 gal/day, the BOD by 25 percent to 1040 mg/L, the TSS by 35 percent to 648 mg/L, and the O & G by 40 percent to 413 mg/L, the aerator basin for a 7-day hydraulic detention time, would need to be approximately 60 ft × 60 ft × 12 ft deep and equipped with two 10-HP floating aerators. The operating sequence would be that the aerator basin would receive flow throughout the one or two daily work shifts, which might be 7 AM to 11 PM, and the aerators would operate from 6 AM to midnight. From midnight to 6 AM, the aerators would be turned off so that sedimentation and denitrification could occur. From 3 to 6 AM, a volume equal to the days flow would be allowed to drain from just below the surface of the aerator basin into the community sewer or into a holding pond for controlled release into the sewer. This treatment could be expected to accomplish reductions of approximately 95 percent for BOD, 90 percent for TSS, and 90 percent for O & G (7). The resulting effluent levels should be acceptable to the municipality without surcharge.

If the effluent is to be treated for direct discharge, then the aerator effluent would be released into subsequent treatment such as an intermittent sand filter. Utilizing sand filtration for the flow of 54,392 gal/day would require a bed about 65 ft square. Anticipated effluent levels for reductions of 60 percent for BOD, 40 percent for TSS, and approximately 100 percent for O & G (7), are shown in Table 14. Comparing these to the Oklahoma NPDES limits and to EPA's BPT levels indicates an effluent acceptable for direct discharge.
TABLE 14

EFFLUENT LEVELS ACHIEVABLE BY EXTENDED AERATION AND INTERMITTANT SAND FILTRATION

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Extended Aeration</th>
<th>Sand Filtration</th>
<th>OK</th>
<th>BPT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs per mg/L 1000 lbs LWK</td>
<td>lbs per mg/L 1000 lbs LWK</td>
<td>NPDES lbs per mg/L 1000 lbs LWK</td>
<td></td>
</tr>
<tr>
<td>BOD</td>
<td>52 0.29</td>
<td>21 0.12</td>
<td>40 0.17</td>
<td></td>
</tr>
<tr>
<td>TSS</td>
<td>65 0.37</td>
<td>39 0.22</td>
<td>45 0.24</td>
<td></td>
</tr>
<tr>
<td>O &amp; G</td>
<td>41 0.23</td>
<td>ND</td>
<td>15 0.06</td>
<td></td>
</tr>
</tbody>
</table>

ND below the detection limit of the analytical technique

COSTS. The wide variations in the local pricing of materials and labor require that cost estimates be very general. With this in mind, the following approximations are offered for the small packinghouse used in above.

It is possible that in-plant modifications could allow the meatpacker the option of discharging to a community sewer with the payment of a user fee plus a surcharge. In addition, such modifications should be self amortizing based on byproduct recovery, reduction in water usage, and lower treatment costs. For example, a flow reduction of 35 percent would lower the Oklahoma City user fee from $2025 to $1316 per month and the maximum surcharge from $869 to $565 per month for an annual savings of over $12,000. For Oklahoma City, the user fee at $1.10/1000 gallons, would be $15,792 per year and the maximum surcharge at $565 per month would be $6,700 per year. This would total over $22,500 per year.

For sewer disposal without the surcharge, the recommended treatment of batch-type extended aeration would present the cost estimates in Table

TABLE 15

BATCH-TYPE EXTENDED AERATION

<table>
<thead>
<tr>
<th>Approximate Capital Costs:</th>
<th>$25,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximate O &amp; M Costs:</td>
<td>8 man-hours/week</td>
</tr>
<tr>
<td>Approximate Power:</td>
<td>9,000 KWH/month</td>
</tr>
<tr>
<td>Approximate Equivalent Annual Costs:</td>
<td>$10,000a</td>
</tr>
</tbody>
</table>

a Structures amortized at 10 percent interest over 20 years.
Equipment amortized at 10 percent interest over 10 years.

15. Note that the approximate annual equivalent cost of $10,000 is higher than the estimated annual surcharge of $6,700; therefore, this option would not be indicated unless in-plant modifications were not installed or
were not effective in lowering the strength and/or volume of the waste to the anticipate levels. The total cost of this option, including user fee, would be about $25,800 per year.

For direct discharge, the cost estimates for batch-type extended aeration and intermittent sand filtration are shown in Table 16. Note the approximate annual equivalent cost of $13,700 is much lower than either of the other two options.

**TABLE 16**

**BATCH-TYPE EXTENDED AERATION PLUS INTERMITTANT SAND FILTRATION**

<table>
<thead>
<tr>
<th>Approximate Capital Costs:</th>
<th>$50,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximate O &amp; M Costs:</td>
<td>10 man-hours/week</td>
</tr>
<tr>
<td>Approximate Power:</td>
<td>9,000 KWH/month</td>
</tr>
<tr>
<td>Approximate Equivalent Annual Costs:</td>
<td>$13,700(^a)</td>
</tr>
</tbody>
</table>

\(^a\) Structures amortized at 10 percent interest over 20 years.

Equipment amortized at 10 percent interest over 10 years.

**Conclusion**

Small packinghouses are presented with three alternatives for wastewater disposal. The first is install in-plant modifications which may produce an effluent acceptable for sewer discharge, and if so, pay the surcharge along with the user fee. The second option is to install in-plant modifications and pretreatment in order to achieve an effluent acceptable for sewer discharge with only the user fee. The third is to install in-plant modifications and complete treatment in order to produce an effluent which can be discharged directly.

Based on the technical and economic constraints incumbent on a small packinghouse, in-plant modifications for volume and strength reduction, followed by batch-type extended aeration and intermittent sand filtration is recommended. This treatment sequence should produce an effluent which will meet present limits for direct discharge and should allow the meatpacker to avoid the sewer user fees and surcharge if, in fact, the meatpacker has the option of disposal through a community sewer.

**REFERENCES**

4. “Meat Products Point Source” EPA Regulations Title 41, Part 2 of the Code of


Mr. Chairman, Ladies and Gentlemen. The Food Animal Hygiene Committee heard reports on:

1) Residue Avoidance Program in Georgia, presented by Dr. Charles N. Dobbins, Jr., Head Extension Veterinary Department, University of Georgia,

2) Overview of the meat rabbit industry in the U.S. based upon a survey conducted by Dr. David M. Bedell, Extension Veterinarian, University of Georgia,

3) Update on public health aspects of mycobacteriosis of swine presented by Dr. John Brown, College of Veterinary Medicine, University of Georgia.

Dr. Dobbins reported on the use of the live animal swab test (LAST) as a screening procedure for the prevention of animal tissues containing harmful drug residues from reaching the consumer public. Based upon a Georgia study involving approximately 20,000 samples, the report indicated that a very small percentage of animals containing violative residues enter the market place. Preliminary evaluation suggests that the LAST test of primary tissues and body fluids other than urine may be used for testing purposes. This would make this procedure more practical especially in swine.

The report by Dr. Bedell on the meat rabbit industry indicates that present information concerning production, slaughtering, and processing meat rabbits is very sparse and not completely accurate. The committee determined that either federal or state inspection service is available to rabbit processors in all states, therefore recommends that no change in the regulatory status of rabbit meat be made at this time.

Dr. Brown reported on the pathogenicity of several isolates of mycobacterium sp. The reported results indicate that the tested isolates of the causative agents of clinical mycobacterium in swine, were not pathogenic to mammals based upon guinea pig studies and only slightly pathogenic to chickens.

I move that this report be referred to the Executive Committee for approval.

Respectively submitted,
David M. Bedell
U. S. ANIMAL HEALTH ASSOCIATION
1983 REPORT OF THE
COMMITTEE ON INFECTIOUS DISEASES OF HORSES

Chairman: C. L. Campbell, Tallahassee, FL
Vice Chairman: R. C. Knowles, Silver Spring, MD

J. B. Anderson, TN; C. E. Boyd, SC; G. C. Cilley, NH; Jesus Castaneda G., Venezuela; LeRoy Coggins, NC; G. B. Estes, VA; P. M. Epple, MD; C. A. Gipson, MD; R. C. Goulding, CA; J. B. Healy, CA; F. M. Jones, Miami; M. J. Keren, NY; W. O. Kester, CO; M. J. Nolan, DC; S. R. Nusbaum, NJ; M. A. Owen, MA; W. E. Pace, FL; Linda Schlater, IA; John Smiley, ME; M. B. Teigland, FL; C. D. Vail, CO; T. E. Walton, CO

The Committee on Infectious Diseases of Horses convened in Las Vegas, Nevada, on October 17, 1983, with some 35 members and visitors in attendance. A quorum present. Principal topics of discussion in the somewhat elongated meeting included equine encephalitis, infectious anemia, contagious metritis, piroplasmosis, vesicular stomatitis and salmonellosis.

The committee was advised of the tragic death of one of its members in an automobile accident some ninety days ago. The member, namely Dr. Victor Schroeder of Mexico, had — through the years — been a driving force in animal disease eradication activities (particularly those involving horses), and contributed materially in providing us annually with detailed progress reports in those areas. His presence will be sorely missed by the committee.

In reporting on encephalitis testing and surveillance, Dr. James Pearson presented data for the past eleven years on equine encephalitis positive cases disclosed by the National Veterinary Services Laboratories (NVSL) upon samples submitted as a part of the on-going VEE surveillance program. Such data may be gleaned from previous reports of this committee; however, for ready reference, a summarization of those results are appended to this year’s report as Exhibit 1. During 1982, samples were submitted to NVSL from 519 horses with clinical signs of encephalitis. Of these, 47 positive cases of the eastern strain were diagnosed from ten states and 27 positive cases of the western strain were diagnosed from eight states. During the first nine months of 1983, samples have been submitted from 423 horses. Of these, 18 positive cases of the eastern strain were diagnosed from six states and 67 positive cases of the western strain were diagnosed from eleven states. While antibody against the Venezuela strain was detected in a few horses, there was no evidence of recent infection with the virulent subtype. In the area of comment on the subject, the committee expressed concern that the results of single samples submitted might be considered presumptive, recognizing that more conclusive (but, obviously, idealistic) results would be obtained from paired sera — usually unobtainable.
Dr. C. A. Gipson, Special Diseases Staff, Veterinary Services, APHIS, reported that during Fiscal Year 1983, 687,810 horses were EIA tested throughout the United States — 3,645 reactors have been disclosed. Attached Exhibit 2 depicts the extent of infection throughout the country on a state-by-state basis.

A general discussion of the Chinese EIA vaccine ensued noting that this topic had been presented in depth at the 1983 meeting of the American Veterinary Medical Association in New York City in July. In view of the interest being evidenced in this vaccine, the committee recommends that USDA review the advisability of bringing into the United States samples of the Chinese EIA antigen for the purpose of evaluation in determining its safety and usefulness within this hemisphere.

Dr. W. W. Buisch of the USDA Emergency Diseases Programs presented to the committee a review of the 1982-83 vesicular stomatis problem as it has occurred throughout a great portion of the United States. It was noted that a large number of horses were affected with the disease in Colorado and other states, in addition to the numerous other species of animals involved.

You will recall in last year’s report the committee focused attention to the fact that in recent months a decline in interest for the seriousness of contagious equine metritis as a disease had been observed in many breeding areas of the United States. This was expressed through the following excerpt from that report: “Certain members of this committee are concerned that the present measures being taken to prevent spread of CEM in the domestic horse population are fraught with danger and such measures should be reviewed. We recommend that the Committee on Infectious Diseases of Horses take the initiative to gather the scientific/regulatory community together to meet on CEM to assemble data of pertinence on this disease — then arrange a meeting with the horse industry of the United States to chart the course that should be taken in dealing with CEM.”

To this end, a summit meeting was convened in Washington, D.C. at the USDA offices on January 5th of this year, there being some 30 affluent subject-intelligible persons in attendance. The significant development of this meeting was the appointment of an ad hoc committee, the purpose of which was to develop a minimum code of practice containing guidelines for the use of regulatory/industry people in the several states to serve as a tool in precluding dissemination of CEM should it reappear in the country. Since sharing the efforts of this committee with involved scientific, regulatory and industry representatives in the past few weeks, suggestions have been submitted for certain modifications. As a consequence, the ad hoc group is returning to the drawing board to further refine the document, which should then be available at an early date.

Our committee recommends, concurrently, that USDA initiate research to develop a more practical aid to the diagnosis of contagious equine metritis, particularly in mares, than that which currently exists.

Considerable discussion ensued regarding rules which had been pub-
lished in the Federal Register in May and June of 1983 regarding in general the testing, scrubbing, and handling of stallions and mares relative to CEM. Very few comments have been received by the Department in response to these publications and the committee, too, had problems in "coming to grips" with the various issues proposed. However, two areas in which the committee took affirmative action was to recommend

1. that the use of properly trained accredited practicing veterinarians be considered for conducting the required testing procedures at approved CEM quarantine stations; and

2. that test mares be permitted to be re-used at such facilities, recognizing the necessity for requisite trace-backs in the event that positive results occur on subsequent testing.

The committee had presented to it a proposed protocol designed to determine if equidae with complement fixation (CF) titers of $4^+$ in 1:10 or less for *Babesia equi* after treatment with Imizole® are capable of transmitting pioroplasmosis. The project, to be funded by a private organization represented by Dr. Patrick Maloney, has requested USDA assistance in developing a protocol and carrying out the proposed project. The committee felt that this is a worthwhile project as proposed with private funding and herein endorses same.

The subcommittee appointed last year to define equine salmonella problems presented an interim report that its mission had not as yet been fully completed and it was requested to continue its ad hoc work for finalization during the forthcoming year.
## EQUINE ENCEPHALITIS POSITIVE CASES

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<td>1973</td>
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<td><strong>477</strong></td>
<td><strong>0</strong></td>
<td><strong>7577</strong></td>
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</table>
Equine Infectious Anemia
ACID TESTS REPORTED FY 1983

W (Approximately twice the actual number of reactor animals.)

3,645
687,810

Number of Positive Reactions Reported
(Approximately twice the actual number of reactor animals.)
REPORT OF THE COMMITTEE ON
PARASITIC DISEASES AND PARASITICIDES

Chairman: R. L. Pyles, New Mexico
Vice Chairman: John H. Gray, Colorado
Committee Members: L. G. Biehl, IL; A. R. Burgess, WY; J. E. Christy, IL;
R. O. Drummond, TX; Robert Gadd, SD; Bill Gallagher, SD; S. C.
Gartman, TX; J. F. Hudelson, CO; Ralph Jones SD; N. W. Kruse, NE;
M. H. Lang, IA; R. P. McDonald, TX; C. H. Miranda, SC; J. H. Niemi, SD;
J. E. Novy, TX; J. R. Pemberton, IA; R. L. Rissler, MD; Glenn O.
Schubert, MD; M. G. Scroggs, OH; P. L. Smith, CA; R. K. Strickland, IA;
William Utterback, CA; A. A. Chadwick, DE.

The committee met on Monday, October 17, 1983 at the Sahara Hotel,
Las Vegas, Nevada.

Meeting called to order at 1:40 p.m. by the Chairman.

Twenty-five persons were in attendance, thirteen of which were committee
members.

Dr. Glenn O. Schubert, Veterinary Services, APHIS, USDA, presented
FY 1983 summaries on Psoroptic cattle scabies and on the Tick Programs
in Texas and Puerto Rico.

FY 1983 — Psoroptic Cattle Scabies — Reported Outbreaks

<table>
<thead>
<tr>
<th>State</th>
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</tr>
<tr>
<td>Kansas</td>
<td>11</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>3</td>
</tr>
</tbody>
</table>

A total of 107 outbreaks in 54 counties in 11 states.

TEXAS TICK PROGRAM

There were only 34 new infestations during FY 1983, 15 of which were
inside the quarantine area next to the Rio Grande River. At this time only
12 of the 34 remain infested.

Apprehensions of Mexican livestock increased 94 percent from 81 in FY
1982 to 157 in FY 1983. Six of 73 cattle and 14 of 84 equines apprehended
were tick infested.

Due to economic problems in Mexico, the treatment of cattle there has
been reduced to almost zero, so it is expected that the numbers of infested
cattle straying into the USA will increase.

PUERTO RICAN TICK PROGRAM

The fever tick program in Puerto Rico continues to move along although
greater progress could be achieved with an increase in resources
committed.

Problems with reinfestations have kept the total number of freed prem-
ises down to 1024 for FY 1983. The Commonwealth Government and the
Commonwealth Department of Agriculture have secured a law and regulations for the control of stray animals which were a major cause of reinfestation. The situation has improved and can be expected to continue to do so.

The fever tick program in Puerto Rico has introduced two new pesticides; one a permethrin formulation "ATROBAN" used at 0.05 percent concentration. This product has a section 24C registration. Another is an Amitraz formulation "TAKTIC" used at a 0.025 percent concentration. This product is used under a section 18 exemption.

They went to a 3-week interval between treatments effective October 1, 1983.

Dr. R. O. Drummond, ARS, USDA, Kerrville, Texas, presented a slide series on "Control of Ticks Systemically with Closantel." Closantel, an amazing new systemic insecticide, that is highly effective for the control of ticks.

A general discussion of Ivermectin as a bovine scabicide was held. We have high hopes that this product will be approved and available by January, 1984. Dr. Schubert pointed out that each state needs to review their laws and/or regulations to determine whether or not amendments need be made to permit this product to be used in their respective programs. He stated that Federal interim rules will not interfere with Ivermectin, if it is approved. At the present time it appears that treated infected or exposed animals need to be isolated for 14 days. Also, treated animals would have a 35 day holding period prior to slaughter.

The Committee passed one resolution requesting new research by ARS, USDA on the apparent problem of insecticide resistance in insects, especially horn flies affecting livestock. This resolution is made a part of these minutes.
REPORT OF THE COMMITTEE ON
PHARMACEUTICALS, PESTICIDES AND
RELATED TOXICOLOGY

Chairman: W. A. Knapp, Jr., Raleigh, NC
Vice Chairman: G. D. Lindsey, Indianapolis, IN

D. A. Armstrong, NE; D. T. Bechtol, TX; W. B. Bixler, VA; Jerry Brunton, VA; W. B. Buck, IL; F. Carter, MO; Tom Cook, DC; L. M. Crawford, MD; G. T. Edds, FL; D. O. Farrington, IN; J. E. Fox, GA; D. A. Gable, VA; R. A. Gessert, VA; R. L. Gillespie, MD; J. S. Gloyd, IL; L. C. Harold, VA; J. S. Hayden, MO; E. J. Humphries, DC; W. Jochle, NJ; D. R. Mackey, CO; G. D. Osweiler, MO; M. G. Scroggs, OH; T. K. Shotwell, TX; J. Silver, CT

The committee met Wednesday afternoon with fifteen members and 31 guests for a total of 46 present. Committee members present were:

D. A. Armstrong, NE; W. B. Bixler, VA; M. A. Vanier for Jerry Brunton, VA; W. B. Buck, IL; Tom Cook, D.C.; D. O. Farrington, IN; J. E. Fox, GA; D. A. Gable, VA; R. A. Gessert, VA; J. S. Hayden, MO; E. J. Humphries, D.C.; G. D. Lindsey, IN; D. R. Mackey, CO; M. G. Scroggs, OH; and W. A. Knapp, NC.

The following topics were presented and discussed:

   William A. Knapp, Jr., D.V.M.

2. Illinois Feed Analysis and Residue Monitoring Program
   William A. Buck, D.V.M.

3. Residue Avoidance Program (RAP)
   G. W. Meyerholz, D.V.M.

4. FDA Policy on Extra Label Drug Use in Food Producing Animals.
   William B. Bixler, D.V.M.

With regards to Minor Species Drugs, a total of 31 applications have been submitted to the Bureau of Veterinary Medicine, Food and Drug Administration for review and possible action—20 in fish and 11 in non-fish. IR-4 has 15 drug projects in process, 14 of which are for intended use in minor species of food animals and one is for a minor use in a major species (cattle). One impediment of considerable magnitude is the fact that sheep are yet to benefit from this program because sheep are classed as a major species in so far as human food safety is concerned. Attempts are being made to classify sheep as a minor species of food annual so that it, too, may benefit from this program by having more FDA approved drugs available to this species.

A veterinarian has been appointed by FDA to serve in a liaison capacity with IR-4. It is anticipated that this person will be able to greatly expedite the work of both IR-4 and BVM in the minor species drug development program. In order for this program to be completely successful, BVM, the sponsors, (drug companies), IR-4, and livestock producers must effectively work together.
Dr. William B. Buck discussed the current status of the Illinois Feed Analysis and Residue Monitoring (FARM) Program and its applicability for identifying and controlling contamination of livestock by chemical biological and possibly radiological sources. It appears that this program, with modifications, could address state and perhaps regional disasters affecting livestock.

Dr. G. W. Meyerholz spoke on the current status of the USDA's (RAP) Residue Avoidance Program in the U.S.A. The primary thrusts of this program at this time are technical and educational, but particularly the latter—educational. Drug distributors and lay drug users are current targets for the educational emphasis of the RAP Program.

Dr. William B. Bixler spoke on FDA's policy of extra label drug use in food producing animals. This represents a tremendous initiative by FDA to stop the misuse of drugs in food animals, i.e. the illegal sale, distribution and use of prescription drugs in food animals. Drugs are being used in species and/or at dose levels that are unapproved by FDA. According to the new BVM policy, drugs must be used in strict accordance with wording on the printed label as to indication(s), dosage and species.

The Committee prepared two resolutions to be submitted to the Resolutions Committee.
The USAHA Committee on Professional Oversight met at 1:30 p.m., Thursday, October 20, 1983.

The Committee at its past four meetings expressed concern regarding the implied warranty involved in signing health certificates. Statements on certain health certificates could place the issuing veterinarian in unwarranted legal jeopardy. At the 1982 meeting a resolution, number 11, addressing this problem was approved by the USAHA. The Committee is concerned about the lack of progress toward relieving the issuing veterinarians of responsibility for certifying to the absence of inapparent disease conditions. The Committee recommends the president of the USAHA mail 1982 resolution number 11 to each state veterinarian and request a response as to their position. It is further recommended a summary be prepared from the responses. A report of the summary should be available to be distributed to the State–Federal Relations Committee prior to its next meeting. The State–Federal Relations Committee should be requested to review and make a recommendation prior to the next USAHA annual meeting.

The Committee discussed five resolutions. Four resolutions involving certified raw milk, federal brucellosis budget, salmonella typing and 100 years of animal health were moved to the Resolution Committee.
REPORT OF THE COMMITTEE ON RABIES

Chairman: Leon Russell, College Station, TX
Vice Chairman: W. R. Miller, Auburn, LA

W. H. Beckenhauer, NE; John Brown, GA; R. R. Brown, AL; D. W. Dreesen, GA; J. W. Glosser, MT; B. Hancock, IA; D. R. Howard, KS; Bruce Kaplan, KY; O. L. Kelsey, LA; F. V. McCasland, TX; J. C. New, TN; J. C. Prucha, MD; F. T. Satalowich, MO; E. E. Shroyer, NY; J. M. Shuler, IN; A. Strating, IA; W. G. Winkler, GA

The Committee met on October 17, 1983 with 20 members and guests present. Old business; Dr. Dennis Howard discussed the proposed Rabies Handbook for Professional and Technical Personnel. Investigation by the Subcommittee led to the conclusion that preparation and distribution of the Handbook was not feasible at this time because of financial and other restraints. The need for timely communication on rabies was evident and the Committee voted to send an appropriate resolution to the Committee on Resolutions.

New business: Five formal papers were presented to the Committee.


4) “A General Overview of a 3 Year Intradermal Human Diploid Cell Rabies Vaccination Program.” Dr. Howard - Manhattan, Kansas.

5) “Update of Antemortam Rabies Diagnosis - Skin Biopsy Technique,” D. R. Howard - Manhattan, Kansas.

Positive discussion was stimulated by each paper. Attendees were solicited for appropriate program ideas for 1984.

The Committee was adjourned.
STATE-FEDERAL RELATIONS COMMITTEE
U. S. A. H. A.

Chairman: J. O. Pearce, Jr., Okeechobee, FL

W. B. Fairchild, LA; H. E. Goldstein, OH; J. F. Hudelson, CO; N. W. Kruse, NE; J. R. Ragan, TN; G. B. Rea, OR; J. C. Shook, MD; M. A. Van Buskirk, PA; D. U. Walker, VT

The State-Federal Relations Committee of the U. S. Animal Health Association met in College Park, Maryland on February 1–4, 1983. Staff reports and consultations were presented by APHIS, ARS, FSIS and the Office of Transportation from USDA and by the Bureau of Veterinary Medicine, FDA.

Adequate programs in animal health must be maintained in order to control the loss of productivity in domestic livestock production due to disease, to prevent or eliminate incursions of foreign animal diseases, and to preserve a credible animal health basis for international commerce in livestock and livestock products.

We recognize that funding for needed animal health activities is particularly difficult to generate in the current economic climate. We further understand that budget adjustments will likely be required.

It is imperative that truly cooperative program judgements be made with meaningful input from state and federal regulatory sources, practicing veterinarians, and livestock industry representatives.

It is our view that program economies can be achieved without crippling or dismantling critical, major programs. To do this, every resource involved must be reevaluated and the most cost effective combinations molded. These resources include state personnel, federal personnel, fee basis veterinary services, and the numerous contributions of livestock producers and the marketing industry. Local decision making and program flexibility must be given high priority, but not to the point of losing minimal national program standards. Administrative overhead must not be allowed to consume resources more critically needed in field performance.

We feel that very little progress has been made since last year's report in the extension of authority to Area VIC's to make routine decisions regarding resource allocation and the priority of various program elements.

We are further disappointed that the state by state review of needs and resources has not been initiated as of the date of this Committee meeting.

It goes without saying that new programs should not be initiated until adequate funding provisions can be made. Further, if justification and resource availability are not adequate to carry on active programs in any area, disruptive restrictions should not be placed or maintained on commerce in the industry until the situation changes.
VECTOR BORN DISEASES

BLUETONGUE

Export markets are being jeopardized from presence of bluetongue virus (B.T.V.) infection and serology titers in cattle in the United States.

This Committee strongly recommends accelerated research in the development of new and improved diagnostic tests for bluetongue infection.

'We appreciate the A.R.S. research program at the Denver Laboratory.'

We urge restraint by State and Federal Health Agents with regard to developing limitation on movement of livestock until such time when the entire Bluetongue and F.H.D. complex is better understood.

TUBERCULOSIS

There has been a decline of tuberculosis herds over the past ten years, 52 herds in FY 1972 to 11 herds in FY 1982. In 1981 all 13 infected herds were depopulated, but in 1982 only 8 of the 11 herds were depopulated.

Depopulation of infected and exposed tuberculosis herds is a technically sound program procedure for eradication of bovine tuberculosis.

According to data available, 20 to 30 percent of the infected herds not depopulated, may contribute to later infection.

This Committee recommends that tuberculosis in cattle be classified as an exotic disease by APHIS-VS-USDA. It is an exotic disease to many states that are accredited free and to those states who are reaching that status.

This Committee strongly recommends continued funding by APHIS-VS to achieve eradication of tuberculosis, to support continued research for development of better test procedures for detection of tuberculosis and provide adequate indemnity for reactors and herd depopulation.

SCABIES

Cattle scabies continues to be a very important and costly disease to the industry in many states. We regret that funds for scabies are not recommended in the President's proposed budget for FY 1984. Every effort should be made by Veterinary Services, with help from the livestock industry, to obtain funds to work for scabies eradication in cattle.

We commend Veterinary Services and the Bureau of Veterinary Medicine for their assistance in working to get ivermectin approved for use in livestock in the United States.

ANAPLASMOSIS

We urge the continuance of research in the field, that will ultimately lead to better control and protect the cattle industry.

POULTRY

The proposed National Cage and Aviary Bird Improvement Plan
(NCABIP) presents a valuable adjunct to existing NPIP programs as well as existing USDA cooperative programs. Veterinary Services, APHIS should take advantage of this voluntary effort and provide the necessary resources to implement the NCABIP program.

A need still exists for research in the development of techniques for Newcastle Disease and Chlamydiosis, as well as determining the parameters of effective antibiotic treatment of the various cage bird types imported and marketed in this country. Some of these birds still present a public health potential. It is recommended that APHIS and ARS provide the necessary research to assist in these problems.

It is recommended that Veterinary Services provide the necessary action to implement as well as officially recognize the program “Certification of VVND Negative Primary Breeding Flocks” for the egg and broiler industries as has been already implemented for the turkey industry.

F.D.A.

This Committee commends the Bureau of Veterinary Medicine for its reassessment of the fast track process for new drug approval through recommendations of the Animal Health Institute. Consolidation of responsibility wholly within B.V.M., together with a more liberal combination drug approval process and development of a policy authorizing marketing based on final approval prior to publication in the Federal Register obviously will permit availability in far less time. Twenty-five major approvals, including seven new animal drugs in 1982 represents outstanding progress all without necessity for changes in the law. This Committee is of the opinion, however, that more effort must be expended toward development of standards of requirement for residue detection which are timely, provide for human safety and are effective.

This Committee remains firm in its recommendation that the zero tolerance provisions of the Delaney Amendment be further researched with the ultimate goal being development of realistic cost/benefit standards applied in considering new drug approvals.

IMPORT-EXPORT

A review of the Import-Export programs revealed the following information Protocols are being written and exchanged with several foreign countries whereby embryos and semen may be exported and imported.

The presence of Vesicular Stomatitis in the United States is preventing the exportation of livestock to Taiwan. Other countries are insisting that animals being exported, originate from states that have been free of the disease for the past 12 months. Efforts are being made to replace these requirements with recognized testing procedures.

The resolution from the USAHA requesting APHIS to promote the “Zone Free Area” concept as it relates to Bluetongue and exportation of livestock, created considerable discussion. The probability that some of the
very small foreign countries might exact the same privilege created second thoughts on the part of several members of the Committee.

The potential hazard presented by the forthcoming 1984 Olympics was discussed. Customs will handle Olympic participants like any other tourist except through expanded facilities due to the anticipated volume concentrated in a short time frame. Horses will be handled at the Los Angeles Quarantine Station which hopefully will be completed by that time.

Experimentation with gamma radiation for potential use on questionable product and hazardous material being carried by passengers, shows promise for the future. Work has not progressed sufficiently to comment further.

A new protocol is being developed for the purpose of importing sheep and goats from scrapie infected countries.

The New York Zoological Society is interested in having St. Catherine Island off the coast of Georgia approved as a post entry quarantine station for ruminants. A decision on the request will be made after an inspection of the proposed area.

SCREWWORM

We urge USDA-APHIS to continue the diligent screwworm work in Mexico, and commend them on the progress made, and urge them to continue to push the free area on toward the final goal, the Isthmus of Tehuantepec.

ANIMAL WELFARE

Excellent progress has been made in assessing the effects of modern production systems upon the welfare and productivity of food animals reared in those systems. Stress, although potentially detrimental to the health and well being of animals, is nonetheless essential to the maintenance of vitality and an active capacity for adoption. USDA-ARS sponsored research is ongoing to identify meaningful measures to totally assess stress in animals.

Welfare of food animals is perceived by the USDA to be an industry problem that should be resolved in concert with the public. To that end the Department prefers to play a neutral role in arbitrating the process of establishing standards for the preservation and care of animals.

VETERINARY BIOLOGICS

The Committee was encouraged to learn of the progress in getting a reduced dosage Strain 19 vaccine that will be manufactured at the recommended viability level and properly labeled, so dilution on the farm will not be necessary.

The cooperation between FDA-BVM and Veterinary Biologics APHIS in efforts to control intrastate, interstate and export biologics and drugs is a real step forward. Their combined efforts to revise the Virus Serum Toxin
Act of 1913 should clarify jurisdiction and expedite approval of new products.

These two agencies working cooperatively and with expertise provided from research should provide programs to provide manufacture drugs and biologics which are safe, effective and necessary for the efficient and economical production of livestock and poultry.

**FSIS**

This Committee was most encouraged with the information report indicating a strong desire to provide total consumer protection, but to continue to reevaluate some of the allied food processing establishments on a cost benefit ratio.

FSIS is demonstrating refreshing leadership in its attempt to correlate animal disease incidence statistics. This data should provide valuable information in evaluating incidence rates, attack rates, seasonal occurrence, and geographical distribution of animal diseases and conditions.

The TRAP program should provide additional consumer protection from the antibiotic contamination of meat. The approach of working with the Cooperative Extension Service should provide livestock producers with adequate awareness of the seriousness of the program. This was previously demonstrated with the sulfa residue problem.

This Committee continues to recommend that the USDA provide the leadership to initiate legislation that will permit state inspected product movement in interstate commerce, and to consider all possibilities to provide additional assistance in the cost sharing of existing state programs.

**ARS**

In times of reduced total funding for program progress it was heartening to hear of accomplishments in administrative realignment, and actual reductions of administrative personnel in favor of programs. There still continues to be some problems in communication between ARS and APHIS in programming and effort toward certain areas of concern. The people we visited with are sincere in their effort to minimize this as rapidly as possible.

The Committee on State and Federal Relations would like to suggest that a direct line of communication be maintained with the Department of Defense on movements and outbreaks of exotic diseases in foreign countries and current research work on foreign diseases that concern the Department of Defense.

It appears that the ability to constructively redirect funds when the availability for additional funding has very limited possibilities in an area that needs wider consideration and better utilization.

**EMERGENCY PROGRAMS**

This Committee supports and encourages APHIS in its commitment to
maintain as its No. 1 priority protection of the domestic livestock industry and wildlife resources from disease incursion, either domestic or foreign. Epidemiologic and diagnostic expertise will be greatly enhanced through expansion of agency programs designed to place key personnel in countries experiencing outbreaks of diseases foreign to this country. Such programs will guarantee "hands on" diagnostic experience and hopefully act as a worldwide early warning system for any possible impending disease threats to the United States. This coupled with emphasis on foreign animal diseases at schools of veterinary medicine, state diagnostic laboratories, the training of wildlife personnel and continuing education of foreign animal disease diagnosticians will result in a system of well trained Epidemiologists. An expanded new edition of the Foreign Animal Disease Manual will benefit this effort. Formation of the North American Vaccine Bank should contribute to stability and mutual cooperation on this continent.

The Committee recommends continued research into the epidemiology of Vesicular Stomatitis and continued effort toward approval of a reference center for Malignant Catarrhal Fever. Heartwater disease eradication in the Western Hemisphere deserves special attention especially in light of the fact that Vector Ticks exist in the United States. Continued support for future African Swine Fever eradication will be enhanced by continued efforts of this country and Canada to facilitate repopulation of swine in the Dominican Republic and Haiti.

VETERINARY SERVICES LABORATORIES

Veterinary Services Laboratories continues to be a critical link in the national network of animal disease diagnostic and control facilities.

The Committee recognizes the increasing difficulty which VSL has in responding to the broad demands for program support, reagent production, and diagnostic reference.

We feel that the proposal to establish user fees to help balance workload and resources is a prudent and necessary action.

We endorse the position that routine testing for export should be handled where possible by state or regional laboratories.

We ask, however, that in withdrawal from its role of carrying out the bulk of such testing, VSL remain mindful of its role as consultant and back-stop to state laboratory diagnosticians.

We urge that adequate construction and operational funding be provided to VSL so that it may:

1) Give adequate support for field program diagnostic needs.
2) Provide reagents for state labs where not otherwise available.
3) Give comprehensive diagnostic reference support to state labs.
4) Provide training to state and/or industry diagnostic laboratory personnel.
SWINE DISEASES

Implementation of existing control programs for swine brucellosis and pseudorabies and consideration of control of other contagious diseases of swine are frustrated by inconsistent and unreliable identification measures. The Committee is disappointed by the apparent lack of enthusiasm on the part of Veterinary Services to address the problem of swine identification. The Committee urges the ARS and Veterinary Services to cooperate in an effort to develop an identification system that will provide an effective means of tracing and recording the interstate movement of swine.

Swine industry and state regulatory officials are looking to the USDA for leadership in the establishment of pseudorabies control measures. Standards for the diagnosis of pseudorabies need to be clearly established. Criteria for quarantine and release of quarantine need to be clearly defined. An effort should be made to develop uniform methods for the control of pseudorabies in our swine population.

BRUCELLOSIS

In view of the progress being made in the Brucellosis Eradication Program the USAHA request that no cuts be made in the program. This Committee urges USDA, APHIS to do everything possible to keep the program moving ahead. This is of utmost importance to the credibility of the Brucellosis and other State Federal disease control programs. The procedure of removing funds appropriated for the brucellosis program for use in other programs cannot be supported by the Committee.

This Committee continues to support the comprehensive past recommendation of the USAHA as reflected in recent annual brucellosis committee reports.

We urge APHIS and ARS to coordinate their efforts to develop better diagnostic procedure and immunizing agents for the Brucellosis program and charges APHIS staff to pursue all avenues of providing a successful eradication effort.

PROFESSIONAL DEVELOPMENT

The new emphasis on professional development is encouraging. We are not sure of the overall benefits from the program with the cutback in APHIS personnel. The opportunity for training of greater numbers of state personnel in the system should be increased. Specialized training in diagnosis of foreign animal diseases by practitioners, industry veterinarians and state laboratory and field personnel should be made available.
Chairman: M. S. Silberman, Atlanta, GA
Vice Chairman: R. L. Crawford, Hyattsville, MD

R. A. Bowen, CO; A. E. Decoteau, MA; P. M. Eppele, AL; Gene A. Erickson, IA; Milton Friend, WI; E. E. Grass, CA; D. E. Herrick, MD; C. J. Mikel, OK; Robert Morgan, TX; G. P. Pierson, ND; Jeanne Roush, DC; D. F. Schwindaman, MD; R. M. Scott, MI; K. C. Sherman, KS; D. J. Williams, GA; R. J. Yedloutschnig, NY

The meeting was called to order at 1:30 p.m. by Werner Heuschele, Acting Chairman in the absence of Morton Silberman who was unable to attend due to an illness. The meeting was attended by 8 committee members and 13 guests. An agenda previously sent to committee members was followned.

The draft of a model law regulating the keeping of exotic animals proposed by the Humane Society of the United States (HSUS) was discussed. Questions were raised regarding interpretations of some of the wording in the proposed law. Action was therefore deferred with the recommendation that committee members send their written comments on this proposal to the committee chairman for transmittal to the HSUS.

The current status of serologic studies on malignant catarrhal fever (MCF) were reported on by Dr. W. P. Heuschele and Dr. A. E. Castro. Preliminary MCF serum antibody prevalence data on captive wild ruminants and domestic cattle were presented. Neutralizing antibody to MCF herpesvirus of wildebeest origin has been detected in 112 of 390 (28.7%) of exotic ruminant sera tested to date. Recent studies revealed that 6 of 8 domestic cattle sera had antibodies to MCF herpesvirus detected by indirect immunofluorescence, and 4 of 8 had MCF virus neutralizing antibodies. This raises the possibility that latent MCF herpesvirus infections may exist in cattle.

A brief discussion was given to encourage the zoological animal exhibitor groups to develop a standardized protocol for a necropsy report for exotic animals to provide consistency.

Dr. D. E. Herrick reviewed the historical background and current regulations relating to permanent postentry quarantine of exotic ruminant animals. Discussion on this subject has occurred in previous meetings due to the concerns of zoological animal exhibitors about inconsistencies in the regulation of imported animals and those born in this country. Dr. Herrick also discussed the draft of a bill being prepared by USDA to authorize the importation of wild ruminants and wild swine with rules similar to those currently applicable to domestic ruminants and swine. Representatives from the American Association of Zoological Parks and Aquariums and the American Association of Zoo Veterinarians expressed concurrence with the proposed changes.

The meeting was adjourned at 3:45 p.m.
EXPERIMENTAL TRANSMISSION OF ANAPLASMA MARGINALE THEILER BY MALES OF DERMACECTOR ALBIPICTUS (PACKARD) AND DERMACECTOR OCCIDENTALIS MARX (ACARI: IXODIDAE)

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The authors thank Duane Hayman, Lynn Winward, Kathleen Niemann, and Sheila Merrigan for technical assistance. The help of Drs. John George and James Keirans in providing uninfected ticks is gratefully acknowledged.

INTRODUCTION

The potential role of adults (particularly males) of 1- and 3-host ixodid ticks in the transmission of Anaplasma marginale, the causative agent of bovine anaplasmosis, is of considerable epidemiologic interest. This subject, together with speculation and observations on interhost transfer by adults and other feeding stages of these ticks, recently was briefly reviewed. Moreover, males of 1-host vector species are suspect because transovarial transmission of the parasite by females of these species may not occur with sufficient frequency to be epizootiologically significant, and the interhost transfer of males might therefore have a critical role in passing the parasite from animal to animal. The interhost transfer of males of 3-host vector species, on the other hand, could be an important means by which A. marginale enters the 3-host tick cycle and is subsequently transmitted. This is true for three reasons: (1) For many 3-host species known or suspected to be natural vectors, only the adults typically feed on cattle, deer, and other ruminants, with larvae and nymphs generally being restricted to small and medium size mammals; (2) Hosts of the immature stages are not known to be a source of A. marginale; and (3) Transovarial
transmission of the parasite by 3-host vectors, as by 1-host vectors, does not appear to be a common event.\textsuperscript{7,12}

Central to the question of whether male ticks in fact have a potentially important role in the transmission of \textit{A. marginale} is their competence as intrastadial, biological vectors of the parasite. To date, apparently only three tick species (all 3-host ticks), \textit{Dermacentor andersoni} Stiles, \textit{D. variabilis} (Say), and \textit{Rhipicephalus simus} Koch, have been shown unequivocally to be intrastadial, biological vectors of \textit{A. marginale}.\textsuperscript{12}

To clarify further the potential role of male ticks in the epizootiology of anaplasmosis, we chose as candidate species the 1-host North American winter tick, \textit{Dermacentor albipictus} (inornate form), and the 3-host Pacific Coast tick, \textit{Dermacentor occidentalis}, which are, respectively, suspected and known natural vectors of \textit{A. marginale} in the United States.\textsuperscript{16,21,22}

We report here the results of a study to assess experimentally the competence of \textit{D. albipictus} and \textit{D. occidentalis} males as intrastadial, biological vectors of \textit{A. marginale}.

**MATERIALS AND METHODS**

\textit{Tick maintenance} — \textit{Dermacentor albipictus} used in this study came from stock collected in Texas and subsequently maintained for several generations on cattle at the U.S. Livestock Insects Laboratory at Kerrville, Texas. During this experiment, the ticks were held at a regime of 11-h light and 16° C:13-h dark and 13° C to approximate conditions associated with the fall-winter activity period of \textit{D. albipictus} in nature. \textit{Dermacentor occidentalis} used in this study came from stock collected in Oregon and subsequently maintained for several years on rabbits at the Rocky Mountain Laboratory, Hamilton, Montana. \textit{Dermacentor occidentalis} was held at 26° C and a 12-h photoperiod. Both species were kept in glass vials closed with silk-screen cloth and within air-tight glass chambers containing saturated solutions of KNO\textsubscript{3}, which provided a relative humidity of ca. 93%. There was no history of hemoparasite infection associated with the ticks.

\textit{Tick feeding} — Ticks were confined within orthopedic stockinettes or under cloth patches cemented\textsuperscript{1} to the clipped backs of stanchioned bovines housed in moated concrete stalls that prevented accidental tick infestation.

\textit{Bovine hosts} — Holstein and Jersey calves were obtained from dairies in Moscow, Idaho, and Othello, Washington, respectively. These premises had no history of anaplasmosis. The calves were 4–7 months-old when used and had been splenectomized 1–5 months previously. Pre-test sera and blood films were negative for anaplasmosis. Blood samples were collected twice weekly, or more frequently, from the jugular veins of all test calves. Sera were tested by the complement-fixation (CF) test.\textsuperscript{21} Blood mixed with ammonium and potassium oxalate anticoagulant was used for

\textsuperscript{1}Big Bull Hip Tag Cement, Bigley Supply Co., Elystan, MI
determining packed cell volume (PCV) and preparing Giemsa-stained thin films. Routine microscopic examination of these films was made to confirm infection and determine parasitemia levels in test calves. All test calves were infested and sprayed with acaricide immediately after the ticks were removed.

Three splenectomized calves (107, 110, 125), on which normal \textit{D. albipictus} were fed, were used as controls for detecting possible intercurrent \textit{Anaplasma} infection in the \textit{D. albipictus} colony. Unfed males of \textit{D. albipictus} used in this experiment were obtained by rearing larvae and nymphs on Calf 107, forcibly removing the ticks as fed nymphs, and holding them \textit{in vitro} for ecdysis. Calf 125, subsequently held with the test calves in a screened building, also served as a sentinel to detect accidental transmission by biting flies. As the \textit{D. occidentalis} colony had been reared for several generations exclusively on rabbits, it was presumed to be free of intercurrent \textit{Anaplasma} infection.

\section*{RESULTS}

Calf 122 was infected with a Virginia strain of \textit{A. marginale} (VAM) by intravenous inoculation of 4 ml of a 1:20 dilution of VAM blood stabilate in bovine fetal calf serum. A total of 312 unfed \textit{D. albipictus} males and 191 unfed \textit{D. occidentalis} males were applied to this calf on day 26 post inoculation, when the parasitemia level was 4.6\%. The two tick species were confined under separate back patches. The parasitemia attained a maximal level of 18.9\% on day 4 post application of the ticks, and was 3.0\% when 169 fed males of \textit{D. albipictus} and 92 fed males of \textit{D. occidentalis} were removed from the calf on day 8 post application. Anaplasmosis in this animal was confirmed by the complement-fixation test.

\textit{Test 1 — delayed transfer and test-feeding of \textit{D. albipictus} males}

Fifteen days after being removed from infected Calf 122, 40 males were applied within a stockinette to the clipped back of susceptible Calf 115. On day 6 post application, 22 live, attached males were recovered from this calf. Calf 115 developed a patent infection ca. 34 days post application of the males, indicating that the ticks had transmitted the parasite (Table 1).

Twenty-nine days after being removed from infected Calf 122, a separate group of 28 males was similarly applied to susceptible Calf 127. On day 7 post application, 13 live, attached males were recovered from this calf. Calf 127 developed a patent infection ca. 38 days post application of the males, indicating that the ticks had transmitted the parasite (Table 1).

\textit{Test 2 — delayed transfer and test-feeding of \textit{D. occidentalis} males}

Twelve days after being removed from infected Calf 122, 34 males were applied, as described, to susceptible Calf 113. On day 6 post application, 25 live, attached males were recovered from this calf. Calf 113 became patent ca. 37 days post application of the males, indicating that the ticks had transmitted the parasite (Table 2).

Of the 25 live males removed from Calf 113, 24 were held \textit{in vitro} for 4
days before being applied to susceptible Calf 123 to test for transmission by delayed serial transfer of the ticks. On day 6 post application, 3 live, attached males were recovered from this calf. The poor yield of live ticks resulted from several of the males becoming trapped in the stockinette cement. Calf 123 became patent ca. 38 days post application of the males, indicating that the ticks had transmitted the parasite 22 days after being removed from infected Calf 122 (Table 2). These males had been held 12 days in vitro, test-fed for 6 days on Calf 113, and held an additional 4 days in vitro before being test-fed on Calf 123.

Twenty-seven days after being removed from infected Calf 122, a separate group of 14 males was applied to susceptible Calf 126. On day 7 post application, 7 live, attached males were recovered (a total of 10 males were seen to have attached during the 7-day test-feeding). Calf 126 remained negative for 97 days (Table 2), when it was challenged with infected blood. This calf developed patent anaplasmosis by day 13 post challenge. Challenge infection was confirmed by the complement-fixation test.

Calf 125, which served as a control for demonstrating the absence of intercurrent infection in the *D. albipictus* colony and of transmission by flies, remained negative, as did Calves 107 and 110, as revealed by thin blood films and the complement-fixation test.

**DISCUSSION**

This is the first record unequivocally incriminating the males of *D. albipictus* and *D. occidentalis* as intrastadial, biological vectors of *A. marginale* under experimental conditions, and it is apparently the first such record for males of a 1-host tick species. These findings confirm the results of an earlier, preliminary study which suggested that *D. albipictus* males may be competent intrastadial, biological vectors of this parasite.¹

The ability of 1-host tick males to act as intrastadial, biological vectors of *A. marginale* has potential significance in that if such males transfer to more than one host animal in the field, they could acquire and transmit the parasite in the absence of infection in the host animal on which they fed as immatures. If true, this would increase substantially the vector potential of 1-host ticks, perhaps including such important vector species as *Boophilus microplus* (Canestrini).

Transmission of *A. marginale* by as few as three *D. occidentalis* males in the present study (Test 2) suggests that males of this species are efficient vectors. The reason for the failure of the 10 *D. occidentalis* males to transmit the parasite when fed on Calf 126 after a delayed transfer of 27 days is not known, but may simply reflect failure of these ticks to have acquired infection when fed on Calf 122. Transmission of the parasite by *D. occidentalis* males after a delayed serial transfer (Test 2) is potentially significant in that if such males, once infected, were to transfer serially to several host animals in the field, they might infect these animals without requiring additional exposure to the parasite. There is apparently only one other published report of *A. marginale* transmission by serially transferred male ticks, that involving males of *D. andersonii.*¹
The potential of *D. occidentalis* males as intrastadial, biological vectors of *A. marginale* could have greater importance than may be generally recognized. Although it is frequently mentioned in the literature that this tick transmits the parasite transovarially and that its immature stages occur on cattle and other ruminants, unqualified acceptance of these claims as reflecting common events in nature may not be warranted. The view that this tick transmits the parasite transovarially is based on a single study, which apparently did not address the possibility of accidental fly transmission and whose positive results were not confirmed in a subsequent study. Similarly, the presence of immature *D. occidentalis* on ruminants may in fact be a rare event. It is pertinent that an extensive survey of ectoparasites on California deer, involving the examination of numerous digested hides from animals killed in all seasons over a 2-year period, revealed that only 0.1% of the *D. occidentalis* ticks present on the deer were immature stages. It is not unreasonable to assume that cattle in the same locality would show a similar infestation pattern. Consequently, the males of *D. occidentalis* could represent an important means by which *A. marginale* enters the 3-host cycle of this vector species.

Finally, the true significance of male tick vector competence in the epizootiology of anaplasmosis cannot be accurately assessed without more information on the frequency of interhost transfer by males in the field. It is hoped that this important aspect will receive the attention it appears to deserve.

**SUMMARY**

An investigation of the vector competence of males of the 1-host tick, *Dermacentor albipectus* (inornate form), and the 3-host tick, *Dermacentor occidentalis*, for *Anaplasma marginale* (Virginia strain) revealed experimentally that the males of both species are intrastadial, biological vectors capable of transmitting this parasite.

**REFERENCES**


15. Wilkinson, P. R. Personal communication.


### TABLE 1

Transmission of *Anaplasma marginale* to Calves by Delayed Transfer of *Dermacentor albipictus* Males

<table>
<thead>
<tr>
<th>Period Ticks Held off the Host</th>
<th>No. of Ticks That Fed/No. of Ticks Applied</th>
<th>Results of Test Feeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 days</td>
<td>22/40</td>
<td>Positive 34, Maximal Parasitemia CF Titer = 1280</td>
</tr>
<tr>
<td>29 days</td>
<td>13/28</td>
<td>Positive 38, Maximal Parasitemia CF Titer = 640</td>
</tr>
</tbody>
</table>

(1) Reciprocal of the highest serum dilution giving at least 50% fixation of complement.

### TABLE 2

Transmission of *Anaplasma marginale* to Calves by Delayed Transfer of *Dermacentor occidentalis* Males

<table>
<thead>
<tr>
<th>Period Ticks Held off the Host</th>
<th>No. of Ticks That Fed/No. of Ticks Applied</th>
<th>Results of Test Feeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 days</td>
<td>25/34</td>
<td>Positive 37, Maximal Parasitemia CF Titer = 2560</td>
</tr>
<tr>
<td>4 days(2)</td>
<td>3/24</td>
<td>Positive 38, Maximal Parasitemia CF Titer = 2560</td>
</tr>
<tr>
<td>27 days(2)</td>
<td>10/14</td>
<td>Negative — — —</td>
</tr>
</tbody>
</table>

(1) Reciprocal of the highest serum dilution giving at least 50% fixation of complement.

(2) Delayed serial transfer after 6-day test feeding.
ANAPLASMOSIS IN ALABAMA:
A SEROLOGIC PROFILE (1975–1982) AND CATTLE MARKET
SURVEY (1980)

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ABSTRACT

Anaplasmosis is an arthropod transmitted disease of cattle resulting in
subacute to acute infections characterized by anemia, fever, and icterus.
Subacute and acute infection may result in weight loss and acute infection
is often fatal. Recovered animals become carriers, thus serving as a source
of infection to susceptible cattle. A national survey in 1972–1973 indicated
10% of the cattle in Alabama to be infected with anaplasma. The present
study follows the serologic prevalence of anaplasmosis in Alabama in each
year from 1975–1982 using 59,000 samples submitted for anaplasmosis
serology. Additionally, a survey conducted in 1980 examines the serologic
prevalence of anaplasma infected cattle moving through the cattle mar-
kets in Alabama.

Results from samples submitted for anaplasmosis serology demon-
strated that approximately 4.5% of the samples, representing 14.5% of the
herds, were positive the eight years covered in this report and the preva-
lence of positive cattle was greater in north and central Alabama than in
south Alabama. The 1980 market cattle survey (4800 samples) demon-
strated that 2.8% of the cattle moving through the stockyards were posi-
tive for anaplasmosis and the infection rate was greatest in the northern
area of the State (3.7%) followed by the central area (2.8%) and the
southern area (1.0%). Results suggest that anaplasmosis continues to be
endemic in Alabama and emphasizes the importance of developing pre-
ventive and control methods.

INTRODUCTION

Anaplasmosis is an arthropod transmitted disease of cattle and wild
ruminants resulting in anemia, fever, and icterus. Subacute infection
may result in weight loss, whereas, acute infection is often fatal. Recov-
ered animals become carriers and constitute the primary reservoir of
infection.

In 1973, the economic impact of anaplasmosis on the cattle industry
nationwide was estimated to be 100 million dollars a year. Certainly, as a
result of inflation, the annual loss in the 1980's to anaplasmosis exceeds
the estimate of a decade ago.

Several anaplasmosis surveys from various geographic regions of the
United States have been published. A nationwide survey conducted in

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P.O. Box 952, Auburn, AL 36830
A SEROLOGIC PROFILE (1975–1982)

1972–73 on samples from slaughter cattle indicated that 10% of the Alabama cattle tested positive. Additionally, an anaplasmosis survey in 1981 of livestock in Alabama indicated a 7.5% serologic prevalence. These two surveys constitute the only reports on the prevalence of anaplasmosis in the State of Alabama.

The purposes of the present study were 1) to follow the serologic prevalence of anaplasmosis in Alabama in each year from 1975–1982, 2) to examine the serologic prevalence of anaplasmosis in cattle moving through the cattle markets (stockyards) and market areas in 1980, and 3) to determine the geographic distribution of cattle with antibody to anaplasmosis in Alabama.

MATERIALS AND METHODS

Sampling Procedures — I) Samples for anaplasmosis serology were submitted for various reasons; suspicion and/or conformation of anaplasmosis, anaplasmosis-free herd certification, exportation, or general information. Samplings ranged from individual animals (one animal in a herd) to partial herd tests to entire herds tested. The sampling represented cattle from all of Alabama’s 67 counties.

II) From January 1, 1980–July 3, 1980, 4,800 samples, representing approximately 2% of the market cattle bled for brucella serology, were tested for anaplasmosis. Samples were collected on a daily basis at the Alabama State Federal Brucellosis Laboratory by selecting every 40th sample previously tested for brucellosis. Samples for brucella serology from the cattle markets were in no predetermined order and thus the selections of samples for anaplasmosis constituted an unbiased sampling order. All 52 stockyards operating during the time period were sampled. No effort was made to determine the origin or the final destination of the cattle represented in this survey.

Testing — Sera were tested for antibodies to Anaplasma marginale by the rapid card agglutination test (CAT).

Statistics — Contingency table data by use of the chi-square method was performed to analyze the differences in the numbers of samples and markets positive in the cattle market survey between the northern, central and southern areas of the state.

RESULTS

The number of samples and herds tested and the percentage of cattle and herds serologically positive for anaplasmosis in each year from 1975–1982 is presented in Table 1 and Fig. 1. A total of 58,869 samples, representing 2,558 herds, were tested during the eight years of this study (Table 1). The range of samples positive for anaplasmosis during the eight years test period was 0.8% (1977) — 5.2% (1976 and 1981) with 4.5% of all samples positive (Table 1 and Fig. 1). The range of herds positive for anaplasmosis during the eight years test period was 8.2% (1977) — 17.2% (1978) with 14.5% of all herds positive (Table 1 and Fig. 1). The distribution of positive samples by county is presented in Fig. 2.
The percentage of positives among cattle moving through the cattle markets in Alabama and the regional distribution of the percentage of markets in which serologically positive animals passed is presented in Table 2. Approximately 56% of the 52 cattle markets had one or more animals serologically positive for anaplasmosis (Table 2). Approximately, 73%, 77% and 18% of the markets in northern, central and southern regions, respectively, had cattle with antibody to anaplasmosis. Approximately 75% of the cattle markets whose cattle had serologic evidence of anaplasmosis in Alabama were located in northern and central regions of the State (Table 2 and Fig. 3). Approximately 3% of the 4,800 samples tested were positive statewide with approximately 92% of the positive samples from the northern and central regions (Table 2). Only 3 of the 17 cattle markets in the southern region moved cattle with serologic evidence of anaplasmosis (Fig. 3). Six of the cattle markets in the northern region (5 in Northwest Alabama) and 2 of the cattle markets in the central region (both in West-Central Alabama) had 5% or more of the cattle moving through those markets that were serologically positive for anaplasmosis (Fig. 3).

DISCUSSION

The present study indicates a 4.5% anaplasmosis seropositive rate from approximately 59,000 samples tested from 1975–1982. With the exception of one year, 1977, the sero-positive rate was consistently between 4.2–5.2% (Table 1 and Fig. 1). The low seropositive rate noted in 1977 was due primarily to a relatively lower number of samples submitted with the majority of the samples coming from low-prevalence counties in Southeast Alabama requesting testing for herd certification and/or general information purposes. Results (data not shown) indicate there was no seasonal distribution of seropositive samples. Indeed, no seasonal distribution would be expected in a serologic survey where the majority of seropositive animals are carriers.

The present study indicates a considerably lower anaplasmosis seropositive rate in Alabama than 10% reported by the national survey of 1972–73 or the 7.5% reported by the 1981 livestock survey. The national survey only tested 138 samples, collected during one year and the 1981 survey, although testing 6,300 samples, reported on samples collected only once a week and on the same day each week, thus, the 1981 report consistently reported on the same livestock market areas. The present study utilized approximately 59,000 samples in the eight year submission study and 4,800 samples, collected daily during six months, in the 1980 cattle market survey.

The 1980 cattle market survey suggests approximately 3% of the cattle moving through the cattle markets in Alabama may be seropositive for anaplasmosis. The number of samples seropositive and the number of markets though which seropositive cattle passed were significantly different (P<.005) in both North Alabama and Central Alabama from the markets in South Alabama. The percentage of anaplasma-seropositive cattle moving through markets gives an indication of the role those
animals (carriers) may have in the spreading of anaplasmosis to susceptible animals and herds in the areas that those markets serve.

This study includes more samples than many previously reported anaplasmosis surveys. The eight-year and cattle market surveys, both giving similar results in the geographic distribution of seropositive animals and in seropositive percentages, clearly indicate the Northern and West-Central regions of the State have a greater serologic prevalence of anaplasmosis than other regions of the state. The 1981 survey reported an "apparent clustering" in the North-West counties. The predominant geographic features in North Alabama and West-Central Alabama are the Tennessee River Valley and the Black Warrior, Tombigbee River Systems respectively.

The results from this study emphasize the fact that anaplasmosis is indeed endemic to Alabama and underlines the importance in determining and recognizing the epizootiology of anaplasmosis in Alabama and the Southeast, both in initiating control and/or eradication procedures and in developing preventive methods.

REFERENCES


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</tr>
</thead>
<tbody>
<tr>
<td>No. herds tested</td>
<td>534</td>
<td>243</td>
<td>122</td>
<td>180</td>
<td>253</td>
<td>403</td>
<td>522</td>
<td>501</td>
<td>2,558</td>
</tr>
<tr>
<td>No. herds positive</td>
<td>53</td>
<td>28</td>
<td>10</td>
<td>48</td>
<td>31</td>
<td>64</td>
<td>85</td>
<td>52</td>
<td>371</td>
</tr>
<tr>
<td>Percentage of herds positive</td>
<td>15.9%</td>
<td>11.5%</td>
<td>8.2%</td>
<td>17.9%</td>
<td>18.9%</td>
<td>15.9%</td>
<td>16.3%</td>
<td>10.4%</td>
<td>14.5%</td>
</tr>
<tr>
<td>No. samples tested</td>
<td>7,199</td>
<td>5,907</td>
<td>4,539</td>
<td>5,382</td>
<td>5,415</td>
<td>9,066</td>
<td>13,344</td>
<td>8,017</td>
<td>58,869</td>
</tr>
<tr>
<td>No. samples positive</td>
<td>303</td>
<td>305</td>
<td>35</td>
<td>258</td>
<td>458</td>
<td>694</td>
<td>351</td>
<td>2,667</td>
<td>4.2%</td>
</tr>
<tr>
<td>Percentage of samples positive</td>
<td>4.2%</td>
<td>5.2%</td>
<td>0.8%</td>
<td>4.8%</td>
<td>5.0%</td>
<td>5.2%</td>
<td>4.4%</td>
<td>4.5%</td>
<td>4.5%</td>
</tr>
</tbody>
</table>

Results representing both the number of cattle herds and samples submitted for anaplasmosis serology in Alabama from 1975-1982.
## TABLE 2.
Results of serologic survey for antibody to *Anaplasma* in cattle moving through Alabama cattle markets in 1980.

<table>
<thead>
<tr>
<th></th>
<th>Entire State</th>
<th>Area of State</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>North</td>
</tr>
<tr>
<td>No. of stockyards</td>
<td>52</td>
<td>22</td>
</tr>
<tr>
<td>No. of stockyards positive</td>
<td>29</td>
<td>16(^a)</td>
</tr>
<tr>
<td>Percentage of stockyards positive</td>
<td>56%</td>
<td>73%</td>
</tr>
<tr>
<td>No. of samples</td>
<td>4,804</td>
<td>2,244</td>
</tr>
<tr>
<td>No. of samples positive</td>
<td>136</td>
<td>83(^a)</td>
</tr>
<tr>
<td>Percentage of samples positive</td>
<td>2.8%</td>
<td>3.7%</td>
</tr>
</tbody>
</table>

\(^a\)Numbers with different superscripts in the same row are different (P < .005).
Figure 1. Percentage of serologically positive samples (—) and herds (---) from serum samples submitted for anaplasmosis testing in Alabama (1975-1982).
Figure 2. Percentage of cattle serologically positive for anaplasmosis by county (1975-1982).

58,869 Samples Tested
Key: □ <1%,  ▪ 1 to 10%, □□□□ >10%.
Figure 3. Distribution of cattle markets sampled and percentage breakdown of serum samples positive for anaplasmosis from each market.

Key: 0 Zero, Δ .01 to 5%, □ 5.1 to 10%, ▲ > 10%.
REPORT OF THE COMMITTEE ON ANAPLASMOSIS

Chairman: K. L. Kuttler, Pullman, Washington
Vice Chairman: A. A. Cuthbertson, Elko, NV

J. Lee Alley, AL; J. F. Badger, MO; D. M. Bedell, GA; G. M. Brown, IA;
G. M. Buening, MO; W. B. Fairchild, LA; R. I. Hail, KY; R. F. Hall, GA;
R. L. Hartin, OK; T. J. Holt, MD; J. A. Howarth, CA; J. D. Huber, NV;
M. J. Jochim, CO; E. Wynn Jones, MS; Stuart Lincoln, ID; M. L. Main,
SD; Duane Miksch, KY; Dave Nash, ID; W. G. Nelson, ID; J. O. Pearce,
Jr., FL; M. Ristic, IL; R. C. Searl, IA; N. R. Swanson, WY

The Anaplasmosis Committee met in open session at 1:30 p.m. Thursday, October 20, 1983, in Room 12 of the Sahara Hotel, Las Vegas, Nevada, with 32 in attendance.

The paper entitled "Experimental Transmission of Anaplasma marginale by Dermacentor albipictus and D. occidentalis Males" (Stiller et al.) was presented in general session. The paper "Anaplasmosis in Alabama: A Serological Profile and Survey from 1975–1982" (Haynes et al.) was to have been presented, but Dr. Haynes was not able to attend so the paper will be presented only for publication.

A report was made by Dr. Zaugg of observations made over a 4-year period on a herd of cattle maintained in an Anaplasmosis endemic zone of southern Idaho. Over half of the herd was negative for Anaplasmosis in 1979, and the ratio of negatives/positives has not changed appreciably over the 4-year period, notwithstanding a high tick population in 1982 and 1983. A survey of Anaplasmosis being conducted indicates lower Anaplasmosis prevalence in the intermountain west than seen 20 years ago but a more wide spread distribution in Idaho than we previously thought. This study has yet to be completed and analyzed for meaning, but there appears to be a factor or factors which have influenced Anaplasma prevalence that to date are not fully recognized. Certainly the level of transmission is much lower than anticipated, suggesting that infection has been contained by a lack of transmission in some instances. Acute infections have been encountered on other ranches, resulting in the typically high mortality and morbidity.

Dr. Ritchie reported some structural characteristics of Anaplasma marginale as observed with electron microscopy. Small (0.14–0.35 um microns.) gram negative structures with a double membrane were observed in infected erythrocytes.

Dr. Hidalgo presented a summary of recent research accomplishments reported in the Anaplasmosis research workers meeting. Progress in the development of monoclonal antibodies and their capabilities, in detecting strain differences, suggest the presence of a variety of Anaplasma strains with unique immunologic determinants. Work is continuing on the in vitro cultivation of A. marginale. With the exception of short-term erythrocyte and macrophage cultures, results have been discouraging. Fluorescent antibody and enzyme labeling are techniques which are currently being
investigated as possible diagnostic tools. The number of arthropod vectors proven capable of *Anaplasma* transmission has increased, but their significance in field transmission is still poorly understood. Epidemiological research is increasing, in the hopes of more fully understanding field transmission. No new vaccines on chemotherapeutic agents have been developed, notwithstanding a need in both areas. Efforts to purify and identify antigens on the molecular level are being pursued and could lead to efforts at genetic engineering to produce antigens which, in turn, would be used as vaccines for the prevention of infection.

Dr. C. A. Gipson, Special Disease Staff, APHIS, discussed their interest in the control and regulation of Anaplasmosis. The USDA is producing both the Card Test, and Complement-fixation test antigens for use in the diagnosis of Anaplasmosis. While there is no funding allocated for control of Anaplasmosis, APHIS encourages state and local awareness of this infectious disease of cattle.

Dr. I. Ross Reid, DVM, of the Canadian Department of Agriculture gave a short report on a recent outbreak of anaplasmosis in South Central Saskatchewan in July 1983. This was the first reported outbreak in Canada since 1980. The outbreak has apparently been confined to 12 herds, where approximately 1400 head of reactor cattle have been removed by slaughter. Six herds have been released from quarantine after subsequent tests. Surveillance of this area will continue.

Discussions were conducted by the committee of research priorities, presently available control procedures, and future goals, including possible disease eradication. The consensus was expressed that emphasis on a killed, purified vaccine, free of contaminating erythrocytic stroma of longer duration should be a high research priority. Procedures involving treatment with tetracyclines both orally and parenterally directed at prevention, treatment and radical cures were discussed. Even though these compounds work, they are often expensive and time-consuming. The available vaccine is recommended in some situations, and when used as directed does not usually result in hemolytic anemia of young calves. The vaccine protection, while sufficient to prevent death due to Anaplasmosis, does not prevent infection, hence alone does not significantly reduce the existing reservoir of infection.

It was generally thought that a gradual decline in Anaplasmosis has occurred over the last 20 years. This, if true, may reflect the influence of better insect control, wide spread usage of tetracyclines both parenterally and orally, and the use of the commercially available anaplasmosis vaccine. The supposition of a decline in Anaplasmosis can only be supported by a comprehensive national serological survey. Support for such a program was voiced by members of the Committee.

While eradication in selected areas is possible, a state or national eradication campaign does not seem feasible at this time with the tools presently at hand.
FISCAL YEAR 1982–83 VESICULAR STOMATITIS OUTBREAK

William W. Buisch, D.V.M.
Hyattsville, Maryland

An extensive outbreak of vesicular stomatitis (VS) occurred in the western half of the United States in fiscal year 1982–83. It was caused by a single strand of RNA, bullet-shaped virus of the family Rhabdoviridae, which is probably one of the most studied viruses known to man. Its ability to stimulate host cells to produce interferon is important in public health and, for this reason alone, much research has been pursued.

However, when we consider the pathogenesis of this disease and the resulting epizootiological factors, our field experience indicates that knowledge, relative to animal health concerns in this area, is very limited. The reason for this is probably due to the fact that, historically, epizootics of this disease have only been observed every 10 to 15 years, and therefore, the appropriate research needs have not been fully identified. Nevertheless, when we consider the losses in meat and milk production in herds severely affected with vesicular stomatitis, the importance and need for additional research become readily apparent.

On June 2, 1982, a case of vesicular stomatitis was diagnosed in cattle in Camp Verde, Arizona. It was serotyped as the New Jersey type vesicular stomatitis and was the first case of a major epizootic involving investigations on over 1,324 premises with 617 of these premises laboratory confirmed as positive.

In retrospect, veterinarians in the area reported having seen similar clinical cases on a yearly basis. In fact, some considered the malady as being due to contact with irritants, such as, prickly pear cactus or rough fencing. Soon, however, it was apparent that this was a disease on the move as it followed the Rio Grande and Colorado river valleys into New Mexico and the western slope of Colorado. Almost immediately, large swarms of black gnats, commonly called “buffalo gnats,” were observed on the affected premises. In addition, it was noted that positive cases were generally located within a 5-mile radius of the nearest river and was rarely found in altitudes above 7,000 feet.

By the end of September, the disease had spread northward throughout nine States (Arizona, New Mexico, Colorado, Utah, Wyoming, Idaho, Montana, Nebraska, and South Dakota). It was assumed by most animal health officials that the outbreak would end with the first frost and the subsequent disappearance of insect vectors. This, however, was not the case. It was soon evident that contact spread would play a major role. In fact, in October–November of 1982, a large dairy sale in Colorado and sales from a dealer in Idaho seemed to account for the spread to native animals in an additional five States (California, Washington, Oregon, Kansas, and Missouri).

Although bovine and equine were primarily affected, other species reportedly affected included caprine, ovine, porcine, canine, and man
VESICULAR STOMATITIS OUTBREAK

(Homo sapiens). Oral lesions were commonly observed; however, coronary lesions were rarely observed, and generally only in equine. Teat lesions were observed in dairy animals, especially in animals being milked.

The economic losses in some cases were most severe. This was due in part to a drop in production, especially in dairy animals, and to the establishment of secondary infection. Often this resulted in a culling of livestock causing the value of animals to drop to a fraction of the normal sale value.

Not only is vesicular stomatitis important from an economic point of view, but it is also important in that it is a vesicular disease which can be easily confused with diseases such as foot-and-mouth disease (FMD), vesicular exanthema, and swine vesicular disease. Even though vesicular stomatitis is the only one of these diseases that causes infection in horses; nevertheless, specific laboratory tests are needed to provide a definitive diagnosis. Clinical signs and symptoms of field cases alone are not sufficient. The risk of misdiagnosing vesicular stomatitis for a case of FMD is not worth the consequences. In addition, during a vesicular stomatitis outbreak, our vulnerability to an introduction of FMD is greater and, therefore, our surveillance efforts must be even more diligent.

As in the past, the Food Safety and Inspection Service provided much needed surveillance by closely monitoring all livestock slaughtered in order to detect visible evidence of vesicular lesions. This assistance was greatly valued in further eliminating the possibility of an introduction of foreign animal disease.

International interest in this epizootic resulted in Taiwan banning the importation of livestock and products from affected States. Also, Canada had similar restrictions relative to livestock. Other countries added import requirements including a complement-fixation test for vesicular stomatitis on livestock being exported to their country.

With the production losses noted, biologics firms were encouraged to develop a "killed" vesicular stomatitis vaccine. In Denver, Colorado, the Colorado Serum Company, and in Des Moines, Iowa, the Syntex Laboratories produced vaccines which were conditionally approved and licensed.

In January 1983, the Western States Animal Health Association recommended the use of quarantines on affected premises for a minimum period of 30 days. Soon, several States implemented such quarantines and seemed to favorably benefit from their use. Following this, APHIS, with the support of the State animal health authorities, recommended the following: "a State quarantine be issued on all animals on the premises where suspicious vesicular conditions may exist."—and—"When a case is diagnosed positive for vesicular stomatitis, the quarantine remain in effect for at least 30 days after the last clinical signs of the disease have been evident. Release of the quarantine should only be considered after a thorough evaluation and/or laboratory tests for vesicular stomatitis and exotic vesicular diseases have been completed."

With the last positive diagnosis on May 25, 1983, the epizootic was thought to have ended. Even when New Jersey type vesicular stomatitis
was diagnosed in two feral hogs on Ossabaw Island, Georgia, in July 1983, it was still thought to have ended. The Southeastern Cooperative Wildlife Disease Study in Athens, Georgia, demonstrated serologically that vesicular stomatitis had been endemic on Ossabaw Island for several years, and it was considered only a matter of time before clinical signs would be noted.

Then, on September 19, 1983, a horse in Riverton, Wyoming, was observed with lesions suggestive of vesicular stomatitis. The initial serological results were negative on the complement-fixation test and positive on serum neutralization. However, blood samples taken 1 week later were positive on both tests.

This, again, seems to demonstrate how little is known about this particular disease entity and stresses the importance of supporting vesicular stomatitis research.

In conclusion, the major question to be considered is "Is it worth waiting another 10 to 15 years before our vesicular stomatitis concerns are brought to the forefront?" The answer will influence the future of our valued livestock programs and that, of course, depends on us all.

Vesicular Stomatitis — 1982
Vesicular Stomatitis
1982 — 1983

States investigated, POS diagnosis
States investigated, NEG diagnosis
No investigations reported
First Positive Case Vesicular Stomatitis

No Virus Isolation
Vesicular Stomatitis

- Total positive: 617
- Total investigations: 1,324

Chart showing the number of cases and investigations over the months of 1982 and early 1983.
REPORT OF THE COMMITTEE ON BIOLOGICS

Chairman: R. W. Loan, College Station, TX
Vice Chairman: Majon Huff, Denver, CO

D. C. Alexander, Canada; M. H. Bairey, IA; D. E. Baldwin, NE; W. H. Beckenhauer, NE; D. E. Bordt, IL; A. C. Braemer, CA; E. L. Drake, NV; D. A. Espeseth, MD; John Finnell, IL; J. S. Gloya, IL; R. F. Hall, GA; B. B. Hancock, IA; L. E. Hanson, IL; R. E. Horton, NJ; D. W. Johnson, MN; G. L. Johnson, KS; D. E. Kahn, NJ; L. H. Lauerman, Jr., AL; Vincent Marshall, NE; Duane Pankratz, DS; R. J. Price, MD; D. C. Randall, CO; R. C. Stewart, KS; W. C. Stewart, IA; J. D. Todd, KS; P. R. Turner, TX; C. D. Van Houweling, VA; G. B. E. West, CA; Robert Williams, IN

Dr. William W. Buisch, Chief, National Emergency Field Operations, APHIS, presented a paper entitled “Epidemiological Aspects of the 1982–83 Outbreak of Vesicular Stomatitis.” The paper traced the history and spread of the most recent outbreak. Disease outbreaks appeared to be associated with high levels of insect activity and conditions favoring such activity. No new cases of the disease have been confirmed since September 19, 1983. The two biological companies holding conditional licenses for vesicular stomatitis vaccine production reported very little demand for the vaccine since it became available.

Dr. Max L. Crandall, Associate Director for Surveillance and Compliance, BVM, FDA, spoke on “FDA’s Current Activities in Biologics.” By court action FDA has jurisdiction over unlicensed intrastate biologics but as yet a comprehensive program has not been established for regulation of these products. Both FDA and USDA have expressed concern for the purity, safety, potency and effectiveness of unlicensed biologics.

In discussing FDA’s jurisdiction over intrastate biologics manufacturers, Dr. Crandall quoted from FDA’s response to questions directed to it by the House Appropriations Committee. “FDA is obligated under existing law to react to problems which potentially pose a threat to animal and human health, and will continue to respond to these situations.” Dr. Crandall stated further, however, that “FDA supports and applauds” USDA’s draft legislation attempting to consolidate jurisdiction over animal biological products into one agency.

Dr. David A. Espeseth presented an update on USDA’s biologics program and a discussion of the USDA draft “Animal Biological Products Act.” The U.S. Department of Agriculture proposes legislation which would place all biological laboratories under federal regulation. Provision would be made for a transition period during which time intrastate laboratories could become licensed establishments. During the discussion which ensued, support for the general concepts of the proposed act was expressed as well as concern over several sections of the draft legislation. Suggestions for revisions of several sections were presented. Dr. Espeseth agreed to take the comments and suggestions into consideration.
The Committee passed three (3) resolutions and recommends them for adoption by USAHA. By resolution the Biologics Committee:

1. Urged USDA, APHIS to carefully consider suggestions made in the Committee meeting for certain modifications of the draft "Animal Biological Products Act."

2. Urged USDA, APHIS to carefully consider the proposed definition of the term "Animal Biological Product" developed by the Animal Health Institute.

3. Reaffirmed the Committee's continuing support of its previous resolutions that uniform regulations throughout the US assuring safety and efficacy of all veterinary biological products are necessary; expressed the viewpoint that it would be most beneficial to the livestock industry that this authority be vested with the US Department of Agriculture and urged that USAHA strongly support the general concept of the draft "Animal Biological Products Act" with specific comment to come upon the introduction of the bill.

The Committee expressed their appreciation to Dr. Max Crandall and Dr. David Espeseth for their presentations on FDA and USDA activities in Biologics regulation.

**FDA's CURRENT ACTIVITIES IN BIOLOGICS AND DRUGS**

Good afternoon. Dr. Crawford was unable to attend your meeting, and has asked that I serve in his place. He especially wanted me to discuss with you the Bureau of Veterinary Medicine's Activity over the past year in animal biologics.

Last year at this meeting Dr. Crawford informed you of FDA's jurisdiction and regulatory posture for unlicensed intrastate biologics. At that time we indicated a formal statement would be issued in the near future of the Agency's regulatory program for unlicensed animal biologic manufacturers. Although a lot has happened since that time, the Agency has not formally announced a comprehensive program for the regulation of intrastate biologics. A December, 1982 Congressional Conference Report on FY'83 Appropriations for Agriculture, Rural Development, and Related Agencies (Public Law 97–370) directed the FDA (and USDA) to submit a thorough analysis of the advisability and justification of proceeding with a compliance program for the regulation of intrastate veterinary biologics. The report which was submitted in March of this year, expresses the concern of both USDA and FDA for the purity, safety, potency and effectiveness of unlicensed animal biologics. The points addressed in our report are reported here.

The growing unlicensed segment of the animal biologics industry is structured specifically to avoid USDA licensure and remains unregulated by any Federal Agency. It had been assumed that the States have had effective regulatory control over animal biologics not shipped in interstate commerce. However, a questionnaire recently sent to regulatory officials
in each State to determine the extent of individual state regulation of animal biologics disclosed otherwise. Information obtained from 45 States reveals that most do not actively regulate the manufacture and/or marketing of animal biologics. In fact, unlicensed manufacturers are concentrated in States which have no regulatory programs.

Only 13 of 45 States require manufacturers to register with that State. Most State laws cover only distribution and do not monitor the safety and effectiveness or other qualities of biologics. Only two of the States reporting inspect animal biologics manufacturers within the state and may conduct testing of the biologic products.

Several State laws require that animal biologics not licensed by USDA must be approved by a State official prior to distribution and marketing into and within the State. As this implies, unlicensed animal biologics are illegally shipped in interstate commerce, and this has been documented by both USDA and FDA. A number of subterfuges are used to avoid USDA licensure. Mobile laboratories are moved from state to state or products are moved from a central manufacturing point and only labeled in the States where sales are permitted.

In several instances, State officials have become very alarmed at specific unlicensed products or unlicensed manufacturers within their States. One State law clearly limits marketing only to USDA-licensed biologics, expressing concern that unlicensed products may "not have been produced under quality control conditions nor have been adequately tested for biological purity and efficacy on animals." This State’s Board of Agriculture "finds that an imminent peril to the public welfare requires the adoption of this emergency regulation."

In addition to concerns expressed by a number of States, the Canadian Government has recently expressed to FDA its deep concern over the exportation of unlicensed animal biologic products to Canada because of unknown quality standards.

In 1979, USDA sampled and tested 36 serials (lots) of unlicensed animal biologics from 14 manufacturers. Sterility, safety and potency tests were conducted, and an overall failure rate of 56 percent was reported. The failure rate for USDA licensed products ranges from 4 to 5 percent when tested in the same laboratory. Although no specific randomization procedures were used, a USDA official concluded that, "even if biased, the test results demonstrate a significant lack of compliance among many unlicensed firms."

Over the past years, the FDA was not notified of adverse reactions or immunization failures from unlicensed animal biologics. The USDA does not maintain a file of complaints involving unlicensed products. Without this information, we can only estimate the threat posed to the Nation’s animal and human health from the use of unlicensed animal biologics. The purity, safety, potency and effectiveness of unlicensed animal biologics is essentially uncontrolled by State or Federal regulatory agencies. The public does not receive the protection it is due.
On March 17, 1983, Dr. Hayes, the former Commissioner of FDA attended a hearing with this Appropriations Committee. A number of questions from the committee chairman Congressman Whitten and also Congressman Traxler were presented to us for response. The questions requested more detailed information than provided in our report and the budgetary involvement, as well as a request that we suspend all further action until we have this Congressional approval. To this last question we responded:

"We clearly understand that it is the intention of the conferees on our appropriations that FDA will not establish a specific compliance program for regulation of unlicensed animal biologics until such time as approval of our report is received from the appropriate Congressional committees and agree to abide by your wishes. However, the FDA is obligated under existing law to react to problems which potentially pose a threat to animal and human health, and will continue to respond to these situations."

We are unaware of any further response from the committee, and FY'83 has ended.

Without a comprehensive regulatory program for unlicensed intrastate biologics, we will continue to respond to situations which pose a threat to human or animal health. FDA's field offices have been requested to notify the Bureau of Veterinary Medicine of complaints of animal biologics not licensed with USDA. Further the June 1983 issue of the FDA Veterinarian featured an article encouraging veterinary schools and practitioners to notify us of problems encountered from the use of unlicensed animal biologic products.

You may remember that Dr. Crawford has publicly encouraged legislative action to consolidate the jurisdiction of all animal biologics within one Agency. Recently USDA has publicly announced its legislative proposal to not only consolidate jurisdiction, but also to expand the regulatory remedies available to enforce the law. FDA supports and applauds their attempt.

There is another issue concerning animal biologics which is also important. As many of you are aware, USDA and FDA entered into a written agreement or Memorandum of Understanding on May 7, 1982 to establish new procedures to determine regulatory jurisdiction for new high technology products. The two agencies realized the need for this agreement because criteria used in the past to determine which animal drugs are also biologics to be regulated by USDA may not apply to future products resulting from modern technology such as genetic engineering. Even with this agreement, USDA and FDA labored more than a year to determine regulatory jurisdiction over a bovine interferon. In a recent joint decision it was concluded that the bovine interferon properly resided under the jurisdiction of the Federal Food, Drug, and Cosmetic Act. This decision was based upon knowledge of the mechanism of action for the intended effect: the antiviral effect from interferon therapy clearly results from a bio-
chemical and not an immunological process. Nevertheless, the firm in question waited over one year for this decision.

With USDA's new legislative proposal we hope to see a definition which clearly defines an "animal biologic" and is not ambiguous or confusing. A clear definition is needed to prevent the interagency confusion experienced with the bovine interferon, and to prevent unnecessary delays in providing safe and effective products for animal health and the agriculture community.

Presentation by Max L. Crandall, D.V.M., Associate Director for Surveillance & Compliance, Bureau of Veterinary Medicine, Food and Drug Administration, Rockville, Maryland, at the U.S. Animal Health Association Annual Meeting, Las Vegas, Nevada, October 20, 1983.
IMPLICATIONS OF A NEW BLUETONGUE SEROTYPE FOR
THE U.S. LIVESTOCK INDUSTRY

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SUMMARY

The 1st isolation of bluetongue (BT) virus (BTV), serotype 2 in the U.S. is described. Seventeen isolates were obtained from blood samples that were collected from cattle in Florida in 1982. The viruses were isolated more readily after samples were inoculated into embryonated chicken eggs than after direct inoculation of cultured cells or inoculation into sheep. The recovery of an additional serotype of BTV in the U.S. has important implications for the livestock industry: a) serotype 2 is the most frequent serotype isolated from BT disease of sheep in south Africa and for that reason must be considered as a serious potential threat to the U.S. sheep industry; b) mutations and reassortment have been shown to occur among serotypes of BTV in the U.S. In this study we demonstrated that strains of serotype 2 isolated in October and November were different from those isolated in September and were probably naturally occurring reassortant virus populations. The presence in the U.S. of an additional serotype is likely to lead to the appearance of strains of BTV with characteristics different from those of serotypes that have been present for the past 16 to 30 years.

Bluetongue (BT) is a vector-borne viral disease of ruminant animals. The virus (BTV) replicates in both the insect vector and the ruminant host. The changeable nature of BTV is indicated by the existence worldwide of at least 23 serotypes. There is evidence that the double-stranded ribonucleic acid (RNA) genome of BTV, which has 10 segments, undergoes both genetic drift (point mutations) and genetic shift (reassortment) in nature.

The existence of BT disease in sheep in the U.S. was confirmed by virus isolation in 1952. The 1st strains of BTV were subsequently identified as serotype 1, serotype 11 was isolated from a blood sample collected from sheep in 1955, serotype 17 was isolated from a blood sample collected from sheep in 1962, serotype 13 was isolated from blood samples collected from cattle in 1967 and, most recently, serotype 2 was isolated from blood samples collected from cattle in 1982.

This is to acknowledge the excellent technical assistance of Mr. L.H. Thompson in the viral assays and of Ms. Marjorie Alders in the electron and fluorescence microscopy. The cooperation of Drs. Paul Gibbs, and Ellis Greiner, Center for Tropical Animal Health. College of Veterinary Medicine, University of Florida Gainesville, is acknowledged.

Erasmus, B. J., World Reference Center for Bluetongue Serotyping, Veterinary Research Institute, Onderstepoort, Republic of South Africa: Personal communication, 1983.
IMPLICATIONS OF A NEW BLUETONGUE SEROTYPE 91

This report evaluates the different techniques used to obtain isolates of serotype 2, describes the characterization of several of the isolates and discusses the implications of the discovery of a new serotype for the U.S. livestock industry.

MATERIALS AND METHODS

Collection of samples—The samples described in this report were collected from 1 of 3 sentinel herds of cattle in Florida. The sentinel herd consisted of 19 Santa Gertrudis cattle that were approximately a year and a half old and were located near Ona. Cattle were maintained on small plots of grass pasture and were closely observed for signs of illness at the time of monthly blood collection.

Assay of samples—A portion of each of the washed cell fractions from 95 heparinized blood samples that were collected monthly, August through December, 1982, was stored frozen (-80 C) and was subsequently shipped from Gainesville to Denver. Initially, a portion of each blood sample had been inoculated into 4 tubes of each of 4 cell lines; cell cultures were monitored daily for cytopathic effects and blind passaged once before being discarded (Fig 1). In the present study, samples were thawed and diluted 1:10 in phosphate buffered saline (pH 7.2–7.4); the diluted suspension was sonicated 15–30 sec with a 70% pulse, power setting of 5. Samples were inoculated intravascularly with 1.0 ml syringes and 30 ga needles into 11 day-old embryonated chicken eggs (ECE), 15 ECE per sample, 0.2 ml of sample per ECE. The ECE were held at 33.5 C and those that died from the 2nd through the 7th day after inoculation (DAI) were held at 5 C. Whole embryos were macerated in a blender with buffered lactose peptone (pH 7.2). The embryo suspensions were centrifuged at 2000 RPM for 30 min and supernatant fluids were either seeded directly onto a preformed monolayer of BHK cells in 25 cm² plastic flasks (procedure A) or were inoculated into 7 day-old ECE by the yolk sac route (procedure B) (Fig 1a). In procedure B, 4 ECE were inoculated with 0.4 ml each of supernatant fluids from embryo suspensions. The ECE were held 10 days at 33.5 C and those that died from the 3rd through the 10th DAI were macerated in a blender and centrifuged as described above. For procedures A and B, 0.5 ml of supernatant fluids from embryo suspensions were adsorbed onto a monolayer of BHK cells for 1 hr at 36 C after which the inoculum was replaced with 5.0 ml of maintenance medium. Cells were incubated at 36 C for 7 days or until visible cytopathic effect was observed. If no evidence of cytopathology was seen, cells were released from the surface of the plastic

1Sonicator, Cell Disruptor, Model W-375, Heat Systems-Ultrasonics, Inc., Plainview, NY.
2The Virtis Co., Model 60 K, Gardiner, NY.
3Beckman Model J6-B, Beckman Instruments, Palo Alto, CA.
4BHK21 clone 13: American Type Culture Collection, Rockville, MD.
5Eagle's basal minimal essential medium with Earle's salts and 2% fetal calf serum and 4% tryptose phosphate broth.
flask by overnight refrigeration (5 C) and were sonified for 30 sec as described above; the undiluted suspension was subpassaged to a fresh BHK cell monolayer; after 1 hr at 36 C the inoculum was replaced with maintenance medium. All ECE harvests were subpassaged 3 times on BHK cells. Procedure C was identical to procedure B except that, in instances when no ECE had died previously, 2 live ECE were placed at 5 C on the 5th day after intravascular inoculation; these were subsequently treated like the ECE that died from the inoculum (procedure B).

The remainders of each washed cell fraction were combined into 4 pools of approximately 40 ml each and were inoculated subcutaneously and intradermally into each of 4 sheep (Fig 1). Rectal temperatures of sheep were taken twice daily; sheep were examined daily for clinical signs of illness; white blood cell counts were determined for 14 DAI; serums were collected weekly; heparinized blood was collected on alternate days. Each sheep was given a blood autograft (10 ml morning and afternoon) on the 5th through 8th DAI. Immunity challenge was given (6 wk after the 1st inoculation) in the form of 5 x 10^9 cell culture (50%) infectious doses of a BHK cell-adapted strain of BTV serotype 2 recovered from the September sample from calf No. 370 (Table 1). Responses of sheep after challenge were followed for 4 weeks as described above.

Serology—Serums from experimental sheep were examined for antibody to BTV by the BT immunodiffusion (BTID) test and by the plaque neutralization test.  

Experimental sheep—Warhill wethers were approximately 1 year old and were from a closed flock raised near Laramie, WY. Sheep had no detectable antibodies to BTV by the BTID test.

Polyacrylamide gel electrophoresis (PAGE)—The RNA from viral isolates was examined by PAGE. Cells infected with viral strains were pelleted and resuspended in 0.1 M sodium acetate, 0.001 M ethylenediaminetetraacetic acid, pH 5.0. Sodium dodecyl sulfate was added to a 1% final concentration. The RNA was extracted twice with an equal volume of a phenol, M-cresol, 8-hydroxyquinolone mixture and precipitated twice with 3 volumes of 95% ethanol. The RNA was added to a 10% running gel with a 5% stacking gel. Gels were run for 22 hr at 15 mA. Gels were stained with the Gelcode silver stain kit.

Indirect fluorescent antibody test (IFAT)—The IFAT was applied to viral isolates as previously described.

Electron microscopy—Viral isolates were examined by transmission electron microscopy. Negatively stained virus was prepared by a standard method.

Serotyping—the 1st 10 BTV strains recovered were serotyped at the Plum Island Animal Disease Center® (PIADC) and at the Veterinary

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®Upjohn Co., Kalamazoo, MI.

IMPLICATIONS OF A NEW BLUETONGUE SEROTYPE

Research Institute.\textsuperscript{a} All subsequent BTV strains were serotyped at the Arthropod-borne Animal Diseases Research Laboratory as previously described.\textsuperscript{18}

Prototype BTV serotypes—The U.S. prototype strains for serotypes 10, 11, 13 and 17 have been described previously.\textsuperscript{19} The prototype strain for serotype 2 was obtained from PIADC but originated in the Republic of South Africa. The strain was designated 513(6-6) and was derived from a field isolate recovered in 1959 or 1960 after a widespread outbreak of BT in sheep in South Africa.\textsuperscript{a}

RESULTS

A total of 17 BTV strains were obtained from the isolation procedures used; 16 were from non-pooled samples and 1 was from a pool of 24 samples. Isolations from non-pooled samples were as follows: 7 were from samples collected in September, 8 were from October and 1 was from November (Table 1). Blood samples collected from calves in August and December did not yield BTV. The duration of the infection was at least 36 days in 5 calves whose blood yielded BTV from samples collected in September and October. Signs of illness were not observed in the calves by their caretakers at the times of monthly blood collections.

No BTV was isolated in cell cultures inoculated directly from the blood.\textsuperscript{9} Using ECE, procedure A yielded 10 of the BTV strains, procedure B yielded 2 and procedure C yielded 4 (Table 1). The other assay procedure, inoculation of susceptible sheep, yielded 1 BTV strain (Table 2). Except for a mild febrile response (104.0, 104.2 F) in sheep No. 2 on DAI 6, there were no clinical signs of illness in the 4 sheep for 6 weeks after inoculation. Blood that was collected from sheep No. 2 on DAI 9 yielded the single BTV isolate. Precipitin and neutralizing antibodies to BTV were detected in serum from sheep No. 2 beginning 35 DAI; neutralizing antibodies were detected in serum from sheep No. 3 beginning 35 DAI; antibody to BTV was not detectable in serums from sheep No. 1 and 4 until 14 days after an immunity challenge.

The clinical response to immunity challenge indicated that sheep No. 1 and 4 were completely susceptible; they had detectable viremia (for 10 to 12 days), leukopenia (for 3 days), fever (106.4 peak — for 2 to 5 days) and swelling of the lips with hyperemia of the muzzle and oral mucosa. The clinical response to immunity challenge indicated that sheep No. 2 was completely protected; there was no detectable viremia and no clinical signs of illness in this sheep. The clinical response to immunity challenge indicated that sheep No. 3 was partially protected; there was detectable viremia for 1 day, leukopenia for 1 day and a lower fever for 2 days. Sheep No. 2 and 3 had higher titers of neutralizing antibodies to BTV (≥ 1:160) at 3 and 4 weeks after immunity challenge than sheep No. 1 and 4 (1:20). The
rapid increase in neutralizing antibodies was indicative of an anamnestic response and was consistent with the presence of low-level but detectable neutralizing antibodies to BTV before immunity challenge.

Examination of the viral isolates by electron microscopy revealed size and structural features consistent with those described for viruses of the *Orbivirus* genus. Examination of these isolates by fluorescence microscopy identified them as BTV.

Preliminary serotyping tests revealed that the BTV strains were not serotypes 10, 11, 13 or 17. The 10 strains sent to the PIADC were found to be serotype 2. The same 10 strains were sent to the World Reference Center for Bluetongue Serotyping and were confirmed as serotype 2. The BTV strains that were recovered later and serotyped at the Arthropod-borne Animal Diseases Research Laboratory also were found to be serotype 2.

The PAGE procedure was applied to each viral isolate as soon as it was adapted to replicate in BHK cell cultures. The PAGE patterns of the isolates were typical of orbiviruses. Subsequent studies revealed that PAGE patterns of 12 of the isolates of serotype 2 were indistinguishable from the pattern of the South African prototype strain of serotype 2 (Fig 2). The patterns of all serotype 2 strains examined and of the African prototype strain of serotype 2 were remarkably different from U.S. prototype BTV strains for serotypes 10, 11, 13 and 17 (Fig 3). There were differences in 7 to 9 segments between the Ona prototype strain of serotype 2 and any 1 of the 4 domestic serotypes. The patterns of 4 of the strains of serotype 2 were dissimilar when compared with the other 12 strains (Fig 4); reproducible differences by PAGE were seen in genome segments 1, 5, 7, 8 and 9. The 4 dissimilar strains of serotype 2 were from samples collected in October and November; 2 of the dissimilar strains were from calves whose blood yielded virus of the prototype PAGE genome pattern in September (Table 1). The strain of serotype 2 that was recovered by the inoculation of pooled blood samples into sheep No. 2 has not yet been examined by PAGE.

**DISCUSSION**

In the present study it was found that the inoculation of ECE followed by adaptation of viral isolates to BHK cells was more sensitive for the isolation of BTV than either direct inoculation of cell cultures or inoculation of sheep. This could be due in part to the fact that samples from the calves were pooled for inoculation of sheep so that antibody to BTV in 1 blood cell suspension could have reacted with BTV in another sample. Samples were washed 3 times after collection, however, to remove antibody.

Various points of view can be taken in regard to the recognition of an additional serotype of BTV in the U.S. ruminant livestock population. One point of view is that BTV is widespread in the U.S. and that the introduction of an additional serotype is of no consequence. The new serotype was recovered from infected cattle that were not observed to have signs of
IMPLICATIONS OF A NEW BLUETONGUE SEROTYPE

illness. There have been no reports of disease in ruminant livestock naturally infected with this additional serotype.

Another point of view is that there is a serious potential for future problems to emerge due to the presence of an additional serotype of BTV in the U.S. The 1st possibility for future problems is the inherent pathogenicity of serotype 2 for sheep. Serotype 2 is the most frequent cause of BT disease in sheep in the Republic of South Africa and has been for a number of years. The 1st strains of serotype 2 reported in this study could not be distinguished from the South African prototype of serotype 2 by PAGE. That similarity does not mean that the viral strains are identical biochemically or in pathogenicity but it does lead us to believe that the pathogenicity of the U.S. and African strains in sheep and cattle is certainly as likely to be similar as dissimilar. However, the 1st passages of serotype 2 in sheep in the present study in virus isolation attempts and in the subsequent immunity challenge elicited clinical responses that were either inapparent or clinically mild infections. We concluded from these limited observations that the failure of the bovine origin strain of serotype 2 to elicit more severe clinical signs of illness in sheep No. 2 and 3 was more a factor of dose than of inherent lack of pathogenicity. The responses of sheep No. 1 and 4 to cell culture-adapted serotype 2 was not unlike what has been seen with other cell culture-adapted BTV strains in the U.S. Additional passages of domestic strains of serotype 2 in sheep by both needle and vector bite are in progress and will help to answer questions as to the transmissibility and pathogenicity of serotype 2 in U.S. ruminant livestock.

The 2nd possibility for future problems is associated with the changeable nature of BTV. The apparent ability of BTV to undergo mutation and/or reassortment was illustrated in differences among the 17 strains of serotype 2 assayed by PAGE in the present study. Four of the isolates (Table 1) were different in 5 of 10 genome segments from the other isolates (Fig 4) and from the African prototype. This is the 1st documentation of apparent mutation or reassortment in a single episode involving naturally infected cattle in the field. While it is possible that the 4 dissimilar strains of serotype 2 entered into the herd from an outside source, it is more likely that they resulted from mutation or reassortment of the serotype 2 strain that initiated the infection. It is possible that the strain of serotype 2 that initiated the infection experienced mutation in response to a different biochemical milieu during replication in an unfamiliar vertebrate or invertebrate host. The insect vector for BTV in South Africa is Culicoides imicola; the suspected vector in southern Florida is C. insignis and elsewhere in the U.S. is C. variipennis. What is far more likely is that the initiating strain of serotype 2 has undergone reassortment with 1 of the domestic serotypes of BTV (10, 11, 13 or 17) or with a yet unrecognized additional serotype of BTV. There is published evidence of multiple serotype infection of a single vertebrate host and of naturally occurring reassortant strains of BTV. Comparative studies are in progress with strains of BTV serotypes 13 and 17 that originated in Florida. Two-
dimensional oligonucleotide mapping is also being done in order to characterize more completely the biochemical differences among the strains of BTV isolated in this study in comparison with the African prototype strain of serotype 2.

The close similarity of 12 of the strains of serotype 2 to the African prototype isolated 23 years earlier strongly suggests that serotype 2 was introduced into the U.S., rather than evolving from the 4 serotypes that were already present. One means of introduction would be in chronically infected ruminant livestock from the Caribbean Islands, Mexico or South America. The accidental importation of BTV-infected, antibody-negative cattle into the Harry S. Truman Animal Importation Center has been documented. The introduction could have also occurred in chronically infected zoo animals that were imported from Africa. Another possibility is the movement of infected Culicoides spp. from the Caribbean; such movement of infected vectors has been the probable mechanism for introduction of BTV into Portugal, Cyprus and Greece. The welfare of the U.S. livestock industry is dependent upon a better assessment of the risks inherent in the movement of livestock and insect vectors from Mexico, Central and South America and the Caribbean Islands.

Papadapoulos, P., Veterinary Inspector of Attica and Islands, Athens, Greece: Personal communication, 1982.

REFERENCES

IMPLICATIONS OF A NEW BLUETONGUE SEROTYPE


### Table 1 — Bluetongue Virus, Serotype 2, Isolations from Sentinel Calves and Procedures that Yielded Virus

<table>
<thead>
<tr>
<th>Calf No.</th>
<th>1982 September</th>
<th>October</th>
<th>November</th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td>Neg</td>
<td>+ A</td>
<td>Neg</td>
</tr>
<tr>
<td>72</td>
<td>Neg</td>
<td>+ A</td>
<td>Neg</td>
</tr>
<tr>
<td>82</td>
<td>+ C</td>
<td>Neg</td>
<td>Neg</td>
</tr>
<tr>
<td>115</td>
<td>+ B</td>
<td>+ A</td>
<td>Neg</td>
</tr>
<tr>
<td>185</td>
<td>+ B</td>
<td>Neg</td>
<td>Neg</td>
</tr>
<tr>
<td>206</td>
<td>+ A</td>
<td>+ A</td>
<td>Neg</td>
</tr>
<tr>
<td>256</td>
<td>+ C</td>
<td>+ A</td>
<td>Neg</td>
</tr>
<tr>
<td>260</td>
<td>Neg</td>
<td>+ A</td>
<td>Neg</td>
</tr>
<tr>
<td>340</td>
<td>Neg</td>
<td>Neg</td>
<td>+ C</td>
</tr>
<tr>
<td>358</td>
<td>+ C</td>
<td>+ A</td>
<td>Neg</td>
</tr>
<tr>
<td>370</td>
<td>+ A</td>
<td>+ A</td>
<td>Neg</td>
</tr>
</tbody>
</table>

All samples were tested individually as washed red blood cell suspensions that had been frozen at -70°C until testing; 0.2 ml of a 1:10 dilution was inoculated intravascularly into 15 each, 11-day old chicken embryos to begin each isolation procedure. None of 38 blood samples collected in August and December yielded BTV; 8 calves yielding no BTV isolates are not listed.

*Strains of serotype 2 that were dissimilar to other strains and to the African prototype of serotype 2 by polyacrylamide gel electrophoresis.

+ = BTV, serotype 2 isolated
A = Chicken embryos inoculated intravascularly died; embryo suspensions passed directly onto BHK cells
B = Chicken embryos inoculated intravascularly died; embryo suspensions passed to chicken embryos yolk sac route; embryo suspensions passed onto BHK cells
C = Chicken embryos inoculated intravascularly harvested alive 5th day; embryo suspensions passed into chicken embryos yolk sac route; embryo suspensions passed onto BHK cells
Table 2 — Results of Inoculation of Blood Samples from Calves into Sheep for Virus Detection

| Sheep No. | No. of blood samples in pool | Samples in pool yielding BTV when tested in chicken embryos | Isolation of BTV from sheep | Antibody to BTV before immunity challenge | Response of sheep to immunity challenge
<table>
<thead>
<tr>
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<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Susceptible</td>
</tr>
<tr>
<td>2</td>
<td>24</td>
<td>10</td>
<td>None</td>
<td>+ †</td>
<td>Partial protection</td>
</tr>
<tr>
<td>3</td>
<td>23</td>
<td>6</td>
<td>None</td>
<td>+ ‡</td>
<td>Refractory</td>
</tr>
<tr>
<td>4</td>
<td>23</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Susceptible</td>
</tr>
</tbody>
</table>

Washed blood cell suspensions were pooled in the sequence that they were collected from 19 calves in the sentinel herd from August through December, 1982.

*BTV serotype 2 was recovered from a heparinized blood sample collected 9 days after inoculation.

+Precipitin and neutralizing antibodies to BTV was detected beginning 35 days after inoculation.

Neutralizing but not precipitin antibodies were detected beginning 35 days after inoculation; precipitin antibodies were detected 7 days after immunity challenge.

Immunity challenge (serotype 2) was given 6 weeks after original inoculation of sheep with pooled blood samples from calves.

Figure 1 — Laboratory techniques used for attempted isolation of BTV from cattle in sentinel herd near Ona, Florida.

Figure 1a — Procedures for BTV isolation through embryonated eggs.

Figure 2 — Comparison by PAGE of genome segments of BTV serotype 2, African prototype strain and BTV serotype 2, Ona prototype strain.

Figure 3 — Comparison by PAGE of genome segments of BTV, U.S. prototype strains of serotypes 10, 11 and 13 with serotype 2, Ona prototype strain. Serotype 17 is not shown but was very similar to serotype 11.

Figure 4 — Comparison by PAGE of genome segments of BTV serotype 2: A, Ona prototype strain; B, 2nd Ona strain.
Ten ml of blood collected in heparin from each sentinel animal

transported to laboratory on melting ice

Cell fraction washed 3 times in phosphate buffered saline at +4 C

Ultrasonicated to cause lysis of cell membranes

Inoculated

Directly onto cell cultures (See Reference 9)

Into embryonated eggs (See Figure 1a)

Into sheep

6 weeks

Immunity challenge
Procedure A

embryonated eggs intravascular route

\[ \downarrow \]

dead embryos

BHK cells (3 subpassages when needed)

Procedure B

embryonated eggs intravascular route

\[ \downarrow \]

dead embryos

\[ \downarrow \]

embryonated eggs yolk sac route

\[ \downarrow \]

BHK cells (3 subpassages)

Procedure C

embryonated eggs intravascular route

\[ \downarrow \]

live embryos harvested 5th day

\[ \downarrow \]

embryos yolk sac route

\[ \downarrow \]

BHK cells (3 subpassages)
IMPLICATIONS OF A NEW BLUETONGUE SEROTYPE
A PROCEDURE FOR CERTIFYING GERMPLASM AND ANIMALS FREE OF BLUETONGUE VIRUS INFECTION

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E. Joy Boswell

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Davis, California 95616

Bluetongue (BT) is a viral infection and disease of most ruminant species. Clinical manifestations of disease occur most often in sheep and white-tailed deer. Bluetongue disease in cattle is relatively uncommon, even though infection may be common in endemic areas.1,2 Presently there are 23 known serotypes of bluetongue in the world, five of which occur in the United States.3,4

Much of the concern about bluetongue relates to the fact that countries with no evidence of infection or those with limited numbers of BTV serotypes do not want exotic serotypes introduced into their respective country. Of major concern in this context is the report that a bull shed virus in semen, that cattle may serve as the overwintering host of bluetongue virus, and in one instance an animal was infected for years.5 This has led many countries to develop strict regulatory measures governing the importation of animals and germplasm. The basis for determining animals free of bluetongue virus infection has been either the complement-fixation (CF) or bluetongue immunodiffusion test (BTID). Neither of these tests address whether virus is present in the animal or germplasm, nor do the tests identify all animals that have been infected.2

In order to certify germplasm free of bluetongue virus, a protocol was prepared, submitted to regulatory officials and scientists in a European Economic Community Country (EEC), modified and finally accepted. Following this 3 serologically positive (BTID tests) bulls were identified and subjected to a study for up to 6 weeks. A description of the protocol and results of the study for certifying semen free of bluetongue are described.

CERTIFICATION PROTOCOL

Samples, consisting of semen, heparinized blood and serum, were collected from bulls during the months when insects (Culicoides spp.) capable of transmitting BTV were not active. In western United States, BTV infection has not been observed from January through April.2 In the area where these bulls were maintained, the first insect-killing frosts occur in late September or early October. Semen was collected twice a week from bulls between December and March.

The criteria for certifying bulls and semen free of active BTV infection was as follows (Fig. 1):

1) Blood and semen were determined to be free of BTV infection by:
inoculation of washed, sonicated blood into 6 embryonating chickens eggs (ECE), b) inoculation of 3 ml undiluted blood into sheep, and c) inoculation of 0.5 ml of semen into the same sheep.

2) Virus neutralization tests using the 4 serotypes of BTV (10, 11, 13, and 17) and 2 serotypes of epizootic hemorrhagic disease virus (EHDV) present in the United States were performed on all serum samples collected from the bulls. BTID and enzyme-linked immunosorbent assay (ELISA) were also performed on all samples. A 4-fold or greater increase in antibody titer (virus neutralization or ELISA) was considered suspect for active BTV and/or EHDV infection.

3) Each sheep was inoculated 2 times a week with semen and blood from the same bull for up to 3 weeks. Heparinized blood samples were collected twice a week from sheep from the time of initial inoculation through 28 days following the last inoculation. The heparinized bloods were assayed for virus by inoculation of ECE. Serum samples collected once a week from time of inoculation through 28 days following the last inoculation were subjected to BTID and virus neutralization.

SAMPLING SCHEDULE

The sampling schedule for two bulls was as follows:

December 20 and 30, 1982 and January 6, 10, 14, 17 and 20, 1983. The third bull was sampled on December 20 and 30, 1982; January 6, 10, 14, 17, 20, 24, 27, February 3, 7, 10 and 17, 1983.

Heparinized blood and blood for serum were collected at the time of semen collection. Semen was aliquoted and 0.5 ml undiluted semen in a sterile vial along with blood samples were placed on melting ice and transported by air express 1,200 miles to the School of Veterinary Medicine, University of California-Davis. Serologic studies were performed at the end of the collection period.

RESULTS

No virus was isolated from the bulls blood by means of inoculation of ECE's or sheep (Table 1). Semen collected at the same time blood samples were taken did not yield virus upon inoculation of sheep. Sheep receiving blood and semen during the study did not seroconvert as determined by BTID or neutralization tests and no virus was isolated from their blood by ECE inoculation.

SEROLOGY

All 3 bulls were serologically positive by ELISA and virus neutralization at the onset of the study (Table II); Bulls A and B were BTID positive and bull C was BTID negative. Each serum sample submitted on each bull was tested for: a) neutralizing antibody titer to BTV 10, 11, 13 and 17 and EHDV 1 and 2, b) ELISA titer, and c) BTID response (Table II and III).
Neither the neutralization or the ELISA test had greater than a 4 fold fluctuation in titer. The only variations (limited to 4-fold) were in neutralization titer and were the result of tests being performed on separate days. Bulls A and B remained positive and bull C remained negative (BTID) on all samples that were submitted (Table II and III).

Neutralization and BTID tests performed on sheep at weekly intervals through 28 days following the last inoculation of heparinized bull blood and semen did not result in seroconversions by either test.

**DISCUSSION**

The procedures outlined in this study were to define a reasonable and yet comprehensive method of certifying bulls and their semen free of active bluetongue virus infection. A procedure of this type is needed in order to assure regulatory officials that bulls with BTID and neutralizing antibody can be considered free of virus in blood and semen. The opportunity to design and test this protocol provided information which warranted certification of the semen samples tested herein as free of BTV and EHDV.

The protocol was designed to perform direct virus isolation as well as to evaluate amplification systems that are capable of detecting virus that would not be evident through direct inoculation of ECE. Inoculation of susceptible sheep has been reported to be the most sensitive means of recovering virus. This followed by inoculation of ECE were further attempts to recover virus. The serologic results in bulls A and B did not show evidence of significant changes in neutralizing or ELISA antibody activity (Table III). Interim exposure or showering of virus would be expected to result in an increase in antigen thereby enhancing a secondary immune response with elevated antibody titer. BTID seroconversion in bull C did not occur, again indicating no active infection. The serologic profile in sheep receiving blood and semen did not change, confirming the fact that virus was not present in the samples tested by direct virus inoculation.

Another feature included in the design of the study was to collect samples during that time of the year when epidemiologic studies indicate that virus activity and transmissability is at an absolute minimum. This is usually associated with minimal insect vector activity occurring in the winter months in much of the United States. Epidemiologic studies in California indicate that BTV has not been recovered from cattle over a 3 year period during the months of December, January, February, March and April. These months could therefore be the months in which certification for export of animals and germplasm for California and western states should be done.

The sensitivity of the assays used for detecting BTV represent the best available at this time. Although the procedures are expensive, the level of detection is relatively good. Modern biotechnology should provide highly sensitive, inexpensive systems for detecting virus in animals or germplasm. It will be a few years before these methods can be developed, adequately tested and replace the currently accepted procedures.
The major concern leading to the current restriction on importing and exporting animals can be attributed to a poor understanding of the biology of BTV infection and disease. The complexity of the problem is accentuated by the presence of 23 different serotypes of BTV in the world. The report that congenital infection may lead to lifelong infection and that intermittent shedding of virus in semen occurs implicates vertical transmission as one means of spread. Other studies indicate that postnatal infections lead to transient viremias with subsequent shedding of virus in semen. These bulls eventually recover. In these studies, virus was never recovered from semen unless it was also recovered from blood. These studies support the work reported by others verifying that animals once infected do not always contain and/or excrete infectious virus.

SUMMARY

A procedure for certifying bluetongue virus (BTV) serologically positive animals, to be free of active virus infection, is described. The protocol includes inoculation of blood from bulls into embryonated chicken eggs (ECE) and susceptible sheep, as well as inoculation of semen into sheep. The sheep were then monitored for BTV by inoculation of ECE and assayed for seroconversion to BTV antigens. In addition, serum samples collected from bulls during the course of the study were evaluated for changes in the bluetongue immunodiffusion test (BTID), virus neutralization and enzyme-linked immunosorbent assay (ELISA) to determine if an active infection was present. Collection of samples during the months of December to February did not reveal evidence of virus. Since there was no apparent virus or viral shedding the germplasm was certified as free of BTV.

ACKNOWLEDGEMENTS

We appreciate the assistance of the American Breeders Service, DeForest, WI for carrying out this study.

REFERENCES


Figure 1. Protocol for testing bulls free of bluetongue virus. ECE-embryonating chicken eggs; AGID-agar gel immunodiffusion; ELISA-enzyme-linked immunosorbent assay; SN-serum neutralization.
### TABLE I

Virus isolation from bulls by embryonating chicken egg and sheep inoculation

<table>
<thead>
<tr>
<th>Bull</th>
<th>ECE</th>
<th>Sheep inoculation</th>
<th>Number of collections</th>
<th>Specimen collection period</th>
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<tbody>
<tr>
<td>A</td>
<td>NEG</td>
<td>NEG</td>
<td>7</td>
<td>12/20/82-1/20/83</td>
</tr>
<tr>
<td>B</td>
<td>NEG</td>
<td>NEG</td>
<td>7</td>
<td>12/20/82-1/20/83</td>
</tr>
<tr>
<td>C</td>
<td>NEG</td>
<td>NEG</td>
<td>13</td>
<td>12/20/82-2/17/83</td>
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</tbody>
</table>

### TABLE II

Serological profile of bull sera prior to semen collection period

<table>
<thead>
<tr>
<th>Bull</th>
<th>ELISA titer</th>
<th>Virus neutralization titer</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>BTID 10 11 13 17 EHDV-1 EHDV-2</td>
</tr>
<tr>
<td>A</td>
<td>1600</td>
<td>POS 160 160 160 160 10 40</td>
</tr>
<tr>
<td>B</td>
<td>1600</td>
<td>POS 10 160 40 40 40 160</td>
</tr>
<tr>
<td>C</td>
<td>400</td>
<td>NEG 10 10 40 10 10 10</td>
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### TABLE III

Quantitative serological profile of bull sera over time during semen collection period

<table>
<thead>
<tr>
<th>Bull</th>
<th>ELISA &lt; 4-fold</th>
<th>Virus neutralization &lt; 4-fold</th>
<th>Number of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&lt; 4-fold</td>
<td>&lt; 4-fold</td>
<td>7</td>
</tr>
<tr>
<td>B</td>
<td>&lt; 4-fold</td>
<td>&lt; 4-fold</td>
<td>7</td>
</tr>
<tr>
<td>C</td>
<td>&lt; 4-fold</td>
<td>&lt; 4-fold</td>
<td>13</td>
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</table>
The Bluetongue and Bovine Leukosis Committee met Thursday, October 20, 1983. There were 20 committee members present and 45 visitors in attendance at the meeting co-chaired by Drs. Janice Miller and B. I. Osburn. Dr. Miller chaired the session dealing with Bovine Leukosis.

Dr. Mark Thurmond, University of California School of Veterinary Medicine, reported on studies of a high incidence bovine leukosis area in the San Joaquin Valley. Currently the condemnation rate for lymphosarcoma is approximately 700 per 100,000 adult cows slaughtered. The slaughter plants surveyed service an area consisting almost entirely of dairy cattle. Serologic studies show that the prevalence of bovine leukosis virus (BLV) infection in animals presented for slaughter is about 30%, and 1.4% of these have lymphosarcoma. There is a highly significant association of tumor with the presence of antibody to the virus core antigen, p24. During discussion of Dr. Thurmond’s presentation it was noted that the incidence of leukosis in the San Joaquin area is similar to that reported in the high incidence areas of many European countries prior to their initiation of leukosis control programs.

Dr. Keith Steenberg, from the Missouri Department of Agriculture, related experiences of the state’s diagnostic laboratory in providing assistance to individual herd owners who voluntarily entered into programs for control or eradication of BLV. In one herd the prevalence of infection was reduced from 16% to 5% by selective culling of seropositive animals during a 4 year period. At that time all remaining reactors were removed from the herd and it has remained free of BLV for 4 years, based on annual serologic tests. In a second herd the prevalence of infection has been gradually reduced by segregation of seropositive cattle which are milked after the negative herd. During the 4 years this practice has been in effect the prevalence of infection has decreased from 44% to 28% and the herd size has almost doubled. In addition, several negative animals have been sold. It is anticipated that this program will be continued and will lead in a few years to a BLV—free herd. A third approach to leukosis control was illustrated by description of a herd that was specifically assembled from
selected BLV—free stock. Preliminary serologic tests indicate the herd is remaining virus negative.

Dr. William Bulmer, Agriculture Canada, described the pilot program for BLV control in that country. Nine herds containing 877 cattle were selected for the project. Seropositive reactors and their progeny were removed for slaughter after the first serologic (AGID) test and the herds were retested 30, 90 and 180 days later. Thereafter tests were performed at 6-month intervals. Participating owners were paid $1.00 per animal tested, full market value for each animal ordered to slaughter, and trucking costs for removal of the reactors. Participating owners were required to isolate herd replacements until they had passed 2 negative tests at a 30-day interval. Results of the program showed that BLV was eradicated after 2 to 3 tests except where proper testing of herd replacements was not followed as prescribed. Herd owners identified the following problems:

1) Isolation of herd replacements was difficult to achieve on most farms.
2) It was sometimes difficult to obtain satisfactory test-negative replacement.
3) Herds with a high percentage of reactors had problems meeting milk quota obligations while waiting for replacement animals.
4) In some herds it was difficult to assemble the immature animals for testing.
5) In herds without good animal identification systems it was difficult to identify the offspring of reactors.

Most participants in the program were satisfied with the levels of compensation paid and were pleased with the success achieved in eradication of the virus, especially those herd owners interested in exporting cattle to Europe. Agriculture Canada's position of BLV is that the present knowledge of virus transmission and the test procedures available are sufficient to make an eradication program feasible. At present, however, there has not been an indication from the cattle industry that such a program would be supported in Canada.

Dr. Jack Pitcher, Veterinary Services Cattle Diseases Staff, USDA, discussed the status of the proposed certification of Bovine Leukosis Virus—Free Herds. A resolution in support of the plan was passed by the USAHA in 1982. No action has been taken by APHIS, primarily because of concern regarding industry reception of the proposal and its acceptability to U.S. export markets. In discussion that followed Dr. Pitcher's remarks, there were several indications that some segments of the cattle industry would be anxious to pursue the feasibility of implementing a voluntary mechanism for herd certification. Committee consensus was to urge interested industry representatives and appropriate APHIS personnel to initiate cooperative action on the program which was submitted last year.

BLUETONGUE

The bluetongue session chaired by B. I. Osburn addressed observations
on clinical bluetongue disease and on the problems associated with certification.

Dr. Jack Schmitz, College of Veterinary Medicine, Oregon State University, described a condition known as "white eye" or congenital cataracts which has occurred in calves on ranches in eastern Oregon since 1965. Calves, born at full term gestation, are weak and lack the ability to stand, suckle or survive. Many of the calves have cataracts at birth giving rise to the term "white eye." The incidence of affected calves varies from 0.5 to 8% and it occurs on subsequent years on many ranches. Approximately 50% of the calves are born dead and most of the rest die before they are 6 hours old. In the few calves which survive, the lens opacities disappear between 3 weeks and 3 months of age.

A review of the nutritional, genetic and vaccination programs did not reveal any common etiology. Six of 17 calves had hydranencephaly, two had optic nerve atrophy and one had arthrogryposis.

Serological evidence of bluetongue virus agar gel immunodiffusion antibodies was not found in precolostral serum of 10 calves. 3 calves had elevated immunoglobulin levels of 22 to 30 mg/dl. One of seventeen cows giving birth to affected calves on 10 ranches had AGID antibodies to bluetongue virus. All cows had antibodies to bovine virus diarrhea virus. Six samples (4 bone marrow and 2 spleens) yielded either bluetongue and/or epizootic hemorrhagic disease viruses. Bluetongue virus serotype 11 was isolated from 5 calves, and epizootic hemorrhagic disease virus2 from one of the calves infected with bluetongue virus. PI3 virus was isolated as well from 4 calves and 3 cows.

Dr. T. L. Barber, Arthropod-Borne Animal Disease Research Laboratory, Denver presented a historical review of the isolation and characterization of the first bluetongue virus serotype 2 infection to occur in the Western Hemisphere. The information is included as a manuscript in the proceedings.

An outbreak of clinical bluetongue disease was described in a herd of cattle in south central Nebraska by Dr. Gary Anderson, University of Nebraska. The lesions consisted of oral ulcers, widespread dermal edema with multiple ulcers. Histologically, there was an eosinophilic dermatitis associated with ulcers. The lesions closely resembled the experimentally induced disease which has been shown to be an IgE-mediated hypersensitivity.

The second part of the bluetongue meeting was devoted to discussing problems associated with certifying animals and/or germplasm to be free of bluetongue virus infection. Dr. Dave Herrick, and Dr. G. Winegar, Import-Export, Animal Health Plant Inspection Service reviewed past and current international activities. The first bluetongue restrictions placed on importation of domestic and zoological ruminants from countries with exotic serotypes of bluetongue was in 1980. There are no restrictions on movement of animals from Mexico. All animals offered for entry into the United States must be AGID negative. If a positive animal is in a group, it
must be removed; the group reassembled and tested in 30 days. Importer may request and pay for virus isolations on all animals. If all are negative they may be admitted and if one is positive the whole group is rejected.

Dr. Winegar reported on Canadian, Great Britain, Korean, and China’s requirements for importing animals. Negotiations are still underway with China.

A review of certification of semen free of bluetongue prepared by Dr. J. Pearson was presented by Dr. E. A. Carbrey, National Veterinary Services Laboratory, Ames, Iowa. Alternatives for qualification of semen are as follows:

1) The AI center should be located in a low incidence area,
2) Sentinel animals in the vicinity of the AI center must remain serologically negative,
3) Donor bulls should be maintained in an insect-free area,
4) Donor bulls must be seronegative,
5) Hold semen for a minimum of 60 days during which two negative BTID tests can be performed. Eliminate semen from any serologically positive animals,
6) Attempt virus isolation from all semen before it is released.

The alternatives for exporting live cattle include shipment of animals with 2 negative BTID tests during the non-vector season; or if the cattle are in a BTV area, negative BTID test will be required followed by moving the animal to a bluetongue virus free area. Two subsequent BTID tests will qualify the animal as bluetongue virus free.

The Industry’s view of problems associated with certification was summarized by Dr. Don Monke, Plain City, Ohio. Dr. Monke focused primarily on the requirements facing the artificial insemination units. Some of the problems in certifying bulls and bull semen free of bluetongue virus infection for 42 different countries included 16 countries requiring bulls to be serologically negative, 10 countries required the herds to be seronegative, 4 countries require that the AI units be located in bluetongue virus free areas and others require the state to be free of bluetongue virus. In summary, the inconsistent and varied requirements lead to confusion in the industry, government and in negotiations with regulatory officials in other countries and it presents a major and costly management problem for the AI units. Most AI centers are located in low incidence or “bluetongue free” areas. Bulls entering these centers are screened 1 to 3 times before they enter the centers.

The concern raised was why is a herd test or herd of origin test necessary for certification since many AI centers are located in low incidence bluetongue areas where the vectors have a low competency for transmitting bluetongue virus. It was suggested that the recent studies demonstrating that virus is present in the semen only during the time of viremia could form the basis for future certification. This would then make it possible to export semen from serologically negative as well as serologically positive
bulls. Semen and/or embryos could be held for 30 days during which serum samples could be tested for significant serological variations.

Dr. Monke expressed appreciation for the assistance that USDA/APHIS has given the industry. He indicated that the industry and APHIS needs to work from a base of strength in defining valid certification requirements for bluetongue.

Dr. Mike Jochim of the Arthropod-Borne Animal Disease Research Laboratory, Denver reported on the research efforts to identify virus or viral genome in tissues. He pointed out the limitations of serological tests. For this reason, monoclonal antibody technology and in situ hybridization are being studied to determine their sensitivity in recognizing bluetongue virus.

There were no resolutions presented by the committee.

The meeting adjourned at 5:30 p.m.
Experience with the use of Strain 19 for adult vaccination of brucellosis negative cattle has resulted in considerable variation in degree and duration of serological responses from one herd to another.

The objective of this study was to examine some of the factors which may contribute to this variation, including:

1. Dose of Strain 19
2. Breed
3. Pregnancy
4. Calfhood vaccination

MATERIALS AND METHODS

Experimental Animals

Cattle were available for this study from sources in Kentucky and Louisiana.

In Kentucky a state-owned dairy and beef herd, both certified brucellosis free, were made available. The dairy herd was composed of 155 adult Holstein-Friesian cows, all officially calfhood vaccinated. Dairy Herd Improvement Association (DHIA) records of breeding were used to assign cows to groups according to state of pregnancy. Cows from each group were then randomly assigned to the two vaccination treatment groups.

From USDA, APHIS, VS, Dr. Hendricks, Regional Epidemiologist, Columbia, SC, Dr. Lomme, Regional Epidemiologist, Baton Rouge, LA, and Dr. Odenweller, Station Epidemiologist, Frankfort, KY. This study was made possible through the cooperation of Dr. R. I. Hail, State Veterinarian, Kentucky and Dr. W. B. Fairchild, State Veterinarian, Louisiana.

The beef herd was composed predominately of grade Hereford, Angus, Hereford-Angus—mixed and Charolais cattle. All were in either the first or second trimester of pregnancy and none had been calfhood vaccinated. These were likewise evenly assigned to two vaccine groups.

Ten commercial beef herds in Louisiana were selected on the basis of owner cooperation. Approximately 95 percent of those were Brahman-cross cattle. The herds were tested negative for brucellosis and examined for pregnancy at the time of vaccination when alternate cows were assigned to two treatment groups. These herds were not known to have been previously infected with brucellosis.
VACCINATION PROCEDURE

All cattle were vaccinated subcutaneously with either $0.3 \times 10^9$ or $1.0 \times 10^9$ viable *B. abortus* Strain 19 cells in a 2.0 ml volume of buffered diluent.

The same lot of fresh unlyophilized, Strain 19 prepared at the United States Department of Agriculture, National Veterinary Services Laboratory, Ames, Iowa, was used in both the Kentucky and Louisiana cattle.

Data were also tabulated from brucellosis negative herds which had been adult vaccinated during the past two years as part of Louisiana’s brucellosis eradication program. In this case each entire herd was vaccinated with the same dose. A dose of $2.0$ to $3.0 \times 10^9$ Strain 19 cells was used to vaccinate 931 cows in 35 herds and a dose of $0.3$ to $0.4 \times 10^9$ was used to vaccinate 819 cows in 59 herds. These herds were composed predominantly of Brahman-cross cattle. The vaccine used was produced by a commercial biologic company. The appropriate dose of Strain 19 was administered subcutaneously in a 2.0 ml volume. These herds were retested approximately 6 months postvaccination.

Sampling—Blood samples from the special study groups were collected at approximately 3 months and 6 months post vaccination.

Quarter milk samples for bacteriological examination were collected from selected cows in the ten special study Louisiana herds.

SEROLOGICAL TESTS

Serological responses were measured by the buffered brucella antigen test (Card), the rivanol precipitation plate test (RIV) and the complement fixation test (CF) Wisconsin method. All samples were first tested by the Card test. Those showing positive reactions were then subjected to the RIV and CF tests.

RESULTS

The serological responses of calfhood vaccinated dairy cows which were revaccinated as adults are presented in Table I. Only 133 of the 155 cows vaccinated were available for test three months later and 117 for test 6 months postvaccination. All were negative to the Card test.

The results of adult vaccinated beef cows which had not been calfhood vaccinated are shown in Table II. Vaccination with the $0.3 \times 10^9$ dose resulted in fewer cows with positive reactions to the three serological tests. The RIV and CF results were significantly different between vaccine groups.

At 6 months postvaccination, Table III, there was a reduction in the number of sero positive cows as measured by all three tests. The difference between the two doses were statistically significant for the Card and CF tests but not the Riv test.

The serological responses of Brahman-cross cattle at 3 months post-vaccination are presented in Table IV. The group vaccinated with the $0.3 \times 10^9$ dose had relatively fewer Card test positive (28/190) cows (14.7 per-
cent) than those treated with $1.0 \times 10^9$ dose, 44/181 (24 percent). This difference was statistically significant. There was no significant difference for Riv and CF tests.

These same herds of cattle were again tested at 6 months postvaccination, Table V. There were no significant differences between responses to the two doses as measured by the three serological tests.

The relation of pregnancy to serological response is shown in Table VI. At 3 months postvaccination relatively more nonpregnant than pregnant cows were positive to the Card test. This was true for both vaccine treatment groups. For the $0.3 \times 10^9$ group 16/76 (21 percent) of nonpregnant compared to 12/114 (10.5 percent) and in the $1.0 \times 10^9$ group 21/81 (34.4 percent) of the nonpregnant and only 23/120 (19.1 percent) of the pregnant cows were positive to the Card test. Other differences were not significant.

At 6 months after vaccination (Table VII) there was no significant difference between responses of pregnant and nonpregnant cows.

In Table VIII serological results of Louisiana herds vaccinated with a $0.3$ to $0.4 \times 10^9$ dose may be compared with herds vaccinated with a $2.0$ to $3.0 \times 10^9$ Strain 19 dose. The smaller dose resulted in fewer cows with positive reactions to the serological tests. These differences were (Card test 13.9 percent vs. 19.2 percent, Riv test 6.6 percent vs. 12.9 percent and CF test 3.3 percent vs. 7.5 percent) were highly significant.

**DISCUSSION**

In the Kentucky beef herd, fewer serological responses were found in the cattle vaccinated with the $0.3 \times 10^9$ dose. Similar results were seen 3 months and 6 months postvaccination. At 3 months postvaccination the differences were significant for the RIV and CF tests and at 6 months there were significant differences for the Card and CF tests.

There appeared to be a significant difference in response to dose ($0.3$ vs. $1.0 \times 10^9$) in the Louisiana herds as measured by the Card test at 3 months postvaccination. However, this difference was found to be due to the increased frequency of responses by nonpregnant cows in both vaccine dose groups.

Breed differences—at 6 months postvaccination there were no significant differences due to breed in those cattle given the $1.0 \times 10^9$ dose. However, in the cattle vaccinated with the $0.3 \times 10^9$ dose the Hereford Angus group had significantly fewer responses to the Card and RIV tests than did Brahman-cross cattle. There was no significant difference between Charolais and Brahman-cross cattle in either dose group.

Data from the ten Louisiana herds where cattle were vaccinated with either at $0.3 \times 10^9$ or a $1.0 \times 10^9$ dose were compared with data from Louisiana herds which the cattle were vaccinated with a $2.0$ to $3.0 \times 10^9$ dose. There was no significant difference between the $1.0 \times 10^9$ and the $2.0$ to $3.0 \times 10^9$ vaccine groups. When $0.3 \times 10^9$ and $2.0$ to $3.0 \times 10^9$ groups were compared there was a statistically significant difference for the Card and RIV test results.
SUMMARY

1. A transient difference between serological responses of pregnant and nonpregnant cattle was demonstrated.

2. A difference due to breed was found between the Hereford-Angus cross cattle used in this study and Brahman-cross cattle in Louisiana.

3. In Brahman-cross cattle there was statistically significant difference between the $3.0 \times 10^9$ dose and the $0.3 \times 10^9$ but not between $3.0 \times 10^9$ and $1.0 \times 10^9$.

4. The lowest recommended dose ($0.3 \times 10^9$) for adult vaccination produced serological titers which persisted for 6 months or longer. Approximately three percent of the cattle had residual Strain 19 induced titers which could not be differentiated (utilizing RIV and CF tests) from field strain infection.

The authors wish to express our appreciation for the cooperation of Mr. W. Dale Cortney, Farm Manager, Kentucky Reformatory, LaGrange, Kentucky.
# TABLE I

**Serological Responses of Strain 19**  
**Calfhood Vaccinated Cows Revaccinated as Adults**

<table>
<thead>
<tr>
<th>Vaccine Dose</th>
<th>BREED</th>
<th>No. Cows</th>
<th>3 Months Post Vacc.</th>
<th>6 Months Post Vacc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3 x 10^9</td>
<td>Hol</td>
<td>77</td>
<td>62</td>
<td>0</td>
</tr>
<tr>
<td>1.0 x 10^9</td>
<td>Hol</td>
<td>78</td>
<td>71</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>155</strong></td>
<td><strong>133</strong></td>
<td><strong>0</strong></td>
</tr>
</tbody>
</table>

**Card - Buffered Brucella Antigen Test.**  
**Breed - Hol - Holstein**
### Table II

**Serological Responses of Strain 19 Vaccinated Adult Cattle in Brucellosis Negative Herds - Ky**

**3 Months Post Vaccination**

<table>
<thead>
<tr>
<th>Vaccine Dose</th>
<th>Breed</th>
<th>Cows</th>
<th>Card Pos.</th>
<th>Riv.</th>
<th>CF</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3 x 10⁹</td>
<td>Her-Ang</td>
<td>76</td>
<td>5</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>0.3 x 10⁹</td>
<td>Char</td>
<td>52</td>
<td>6</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>128</strong></td>
<td><strong>11</strong></td>
<td><strong>2</strong></td>
<td><strong>7</strong></td>
</tr>
<tr>
<td>1.0 x 10⁹</td>
<td>Her-Ang</td>
<td>67</td>
<td>9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1.0 x 10⁹</td>
<td>Char</td>
<td>48</td>
<td>9</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>115</strong></td>
<td><strong>18</strong></td>
<td><strong>4</strong></td>
<td><strong>4</strong></td>
</tr>
</tbody>
</table>

Card - buffered brucella antigen test;  Riv. - rivanol precpitation plate test.

CF - complement fixation test 12-24 = 2 + 1:10 - 4 + 1:20; ≥41 = 1 + 1:40 or higher.

Breeds - Her-Ang - Hereford, Angus or Hereford-Angus cross;  Char - Charolais

* Certified Brucellosis Free Kentucky Herd
### TABLE III

**SEROLOGICAL RESPONSES OF STRAIN 19 VACCINATED ADULT CATTLE IN BRUCELLOSIS NEGATIVE HERDS - KY**

**6 MONTHS POST VACCINATION**

<table>
<thead>
<tr>
<th>Vaccine Dose</th>
<th>Breed</th>
<th>Cows</th>
<th>Card Pos.</th>
<th>Riv. +25</th>
<th>Riv. +50</th>
<th>CF 12-24</th>
<th>CF &gt;41</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3 x 10⁹</td>
<td>Her-Ang</td>
<td>76</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>0.3 x 10⁹</td>
<td>CHAR</td>
<td>52</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>128</strong></td>
<td><strong>4</strong></td>
<td><strong>0</strong></td>
<td><strong>3</strong></td>
<td><strong>1</strong></td>
<td><strong>1</strong></td>
</tr>
<tr>
<td>1.0 x 10⁹</td>
<td>Her-Ang</td>
<td>67</td>
<td>5</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>1.0 x 10⁹</td>
<td>CHAR</td>
<td>48</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>115</strong></td>
<td><strong>11</strong></td>
<td><strong>2</strong></td>
<td><strong>6</strong></td>
<td><strong>1</strong></td>
<td><strong>9</strong></td>
</tr>
</tbody>
</table>

**Card** - buffered brucella antigen test; **Riv.** - rivanol precipitation plate test.

**CF** - complement fixation test 12-24 = 2 + 1:10 - 4 + 1:20; >41 = 1 + 1:40 or higher.

**Breeds** - Her-Ang - Hereford, Angus or Hereford-Angus cross; **CHAR** - CHAROLAIS

*Certified Brucellosis Free Kentucky Herd*
<table>
<thead>
<tr>
<th>Vaccine Dose</th>
<th>Breed</th>
<th>Cows</th>
<th>Card Pos.</th>
<th>Riv. $\geq 25$</th>
<th>Riv. $\geq 50$</th>
<th>CF 12-24</th>
<th>CF $\geq 41$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.3 \times 10^9$</td>
<td>Brax</td>
<td>190</td>
<td>28</td>
<td>8</td>
<td>19</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>$1.0 \times 10^9$</td>
<td>Brax</td>
<td>181</td>
<td>44</td>
<td>13</td>
<td>23</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>371</td>
<td>72</td>
<td>21</td>
<td>42</td>
<td>13</td>
<td>19</td>
</tr>
</tbody>
</table>

Card - buffered brucella antigen test; Riv. - rivanol precipitation plate test; CF - complement fixation test $12-24 = 2 + 1:10 - 4 + 1:20$; $\geq 41 = 1 + 1:40$ or higher. Breeds - Brax - Brahman cross

* Louisiana Brucellosis Negative Herds
# TABLE V

## Serological Responses of Strain 19 Vaccinated Adult Cattle in Brucellosis Negative Herds - LA*

### 6 Months Post Vaccination

<table>
<thead>
<tr>
<th>Vaccine Dose</th>
<th>Breed</th>
<th>Cows</th>
<th>Card Pos.</th>
<th>Riv. +25</th>
<th>Riv. ≥+50</th>
<th>CF 12-24</th>
<th>CF ≥41</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3 x 10⁹</td>
<td>Brax</td>
<td>200</td>
<td>21</td>
<td>6</td>
<td>10</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>1.0 x 10⁹</td>
<td>Brax</td>
<td>178</td>
<td>24</td>
<td>5</td>
<td>12</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>378</td>
<td>45</td>
<td>11</td>
<td>22</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>

**Card** - buffered brucella antigen test; **Riv.** - rivanol precipitation plate test. CF - complement fixation test $12-24 = 2 + 1:10 - 4 + 1:20; ≥41 = 1 + 1:40$ or higher. **Breeds** - Brax - Brahman cross

*Louisiana Brucellosis Negative Herds*
TABLE VI

THE RELATION OF PREGNANCY OF SEROLOGICAL RESPONSES
OF STRAIN 19 VACCINATED ADULT CATTLE IN BRUCELLOSIS NEGATIVE HERDS - LA*
3 MONTHS POST VACCINATION

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3 x 10^9</td>
<td>No</td>
<td>76</td>
<td>16</td>
<td>15</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>0.3 x 10^9</td>
<td>Yes</td>
<td>114</td>
<td>12</td>
<td>12</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>190</td>
<td>28</td>
<td>27</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>1.0 x 10^9</td>
<td>No</td>
<td>61</td>
<td>21</td>
<td>13</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>1.0 x 10^9</td>
<td>Yes</td>
<td>120</td>
<td>23</td>
<td>23</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>181</td>
<td>44</td>
<td>36</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

CARD - BUFFERED BRUCELLA ANTIGEN TEST;  RIV. - RIVANOL PRECEPITATION PLATE TEST.
CF - COMPLEMENT FIXATION TEST 12-24 = 2 + 1:10 - 4 + 1:20; ≥41 = 1 + 1:40 OR HIGHER.
* LOUISIANA BRUCELLOSIS NEGATIVE HERDS
# TABLE VII

## The Relation of Pregnancy of Serological Responses of Strain 19 Vaccinated Adult Cattle in Brucellosis Negative Herds - LA*

### 6 Months Post Vaccination

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3 x 10⁹</td>
<td>No</td>
<td>82</td>
<td>10</td>
<td>7</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>0.3 x 10⁹</td>
<td>Yes</td>
<td>118</td>
<td>10</td>
<td>9</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>200</td>
<td>20</td>
<td>16</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>1.0 x 10⁹</td>
<td>No</td>
<td>67</td>
<td>9</td>
<td>7</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1.0 x 10⁹</td>
<td>Yes</td>
<td>111</td>
<td>16</td>
<td>10</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>178</td>
<td>25</td>
<td>17</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Card - buffered brucella antigen test; Riv. - rivanol precpitation plate test.

CF - complement fixation test 12-24 = 2 + 1:10 - 4 + 1:20; ≥41 = 1 + 1:40 or higher.

* Louisiana Brucellosis Negative Herds
TABLE VIII

Serological Responses of Strain 19 Vaccinated Adult Cattle in Brucellosis Negative Herds - LA*
6 Months Post Vaccination

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3-0.4 x 10^9</td>
<td>59</td>
<td>819</td>
<td>114</td>
<td>54</td>
<td>27</td>
</tr>
<tr>
<td>2.0-3.0 x 10^9</td>
<td>35</td>
<td>931</td>
<td>179</td>
<td>120</td>
<td>70</td>
</tr>
</tbody>
</table>

Card Pos. - positive to the buffered Brucella antigen test; Riv. Pos. = ≥25; CF - complement fixation test ≥ 1 + 1:40

* - Louisiana Brucellosis Negative Herds

Card Test - 0.4 x 10^9 vs 3.0 x 10^9 \( \chi^2 = 8.71; P > 0.01 \)
Riv Test - 0.4 x 10^9 vs 3.0 x 10^9 \( \chi^2 = 19.25; P > 0.001 \)
CF Test - 0.4 x 10^9 vs 3.0 x 10^9 \( \chi^2 = 12.29; P > 0.001 \)
<table>
<thead>
<tr>
<th>DOSE x10^9</th>
<th>HERD</th>
<th>TIME POSTVAC</th>
<th>CARD</th>
<th>RIV</th>
<th>CF</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3 vs 1.0</td>
<td>KY Beef</td>
<td>3 MO</td>
<td>NS</td>
<td>P 0.05</td>
<td>P 0.01</td>
</tr>
<tr>
<td>0.3 vs 1.0</td>
<td>KY Her-Ang</td>
<td>3 MO</td>
<td>NS</td>
<td>NS</td>
<td>P 0.05</td>
</tr>
<tr>
<td>0.3 vs 1.0</td>
<td>KY Char</td>
<td>3 MO</td>
<td>NS</td>
<td>P 0.05</td>
<td>NS</td>
</tr>
<tr>
<td>0.3 vs 1.0</td>
<td>KY Beef</td>
<td>6 MO</td>
<td>P 0.05</td>
<td>NS</td>
<td>P 0.05</td>
</tr>
<tr>
<td>0.3 vs 1.0</td>
<td>LA Beef</td>
<td>3 MO</td>
<td>P 0.05</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>0.3 vs 1.0</td>
<td>LA Beef</td>
<td>6 MO</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>0.3 vs 0.3</td>
<td>LA Preg vs Nonpreg</td>
<td>3 MO</td>
<td>P 0.05</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>1.0 vs 1.0</td>
<td>LA Preg vs Nonpreg</td>
<td>3 MO</td>
<td>P 0.05</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>0.3 vs 1.0</td>
<td>LA Preg</td>
<td>3 MO</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>0.3 vs 1.0</td>
<td>LA Nonpreg</td>
<td>3 MO</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>0.3 vs 1.0</td>
<td>LA Beef</td>
<td>6 MO</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>0.3-0.4 vs 2.0-3.0</td>
<td>LA Beef</td>
<td>6 MO</td>
<td>P 0.01</td>
<td>P 0.001</td>
<td>P 0.001</td>
</tr>
<tr>
<td>0.3 vs 2.0-3.0</td>
<td>LA Beef</td>
<td>6 MO</td>
<td>P 0.01</td>
<td>NS</td>
<td>P 0.05</td>
</tr>
<tr>
<td>1.0 vs 2.0-3.0</td>
<td>LA Beef</td>
<td>6 MO</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>0.3 vs 0.3</td>
<td>KY Her vs LA</td>
<td>6 MO</td>
<td>P 0.05</td>
<td>P 0.05</td>
<td>NS</td>
</tr>
<tr>
<td>0.3 vs 0.3</td>
<td>KY Char vs LA</td>
<td>6 MO</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>

NS - Not Significant
THE USE OF ELISA AND COMPLEMENT FIXATION TESTS IN MANAGING FIELD OUTBREAKS OF BRUCELLA ABORTUS

Scott L. Reynolds, DVM, MSPH
TEXAS ANIMAL HEALTH COMMISSION
Austin, Texas

INTRODUCTION

The management of cattle infected with Brucella abortus is complicated and challenging. Early detection and isolation of infected cattle within a herd is of paramount importance. In a previous study conducted on a Jersey herd chronically infected with B. abortus, our data suggested that the Automated Complement Fixation test (ACF) predicted infection 21 days prior to calving. The sensitive Enzyme-Linked Immunosorbent Assay (ELISA) procedure capable of detecting antibody present in minimal quantities has recently been used to study serological responses to B. abortus. Few studies have been reported on the use of the assay for pinpointing foci of infections in problem herds. The purpose of this report is to present preliminary data on the usefulness of both ELISA and ACF tests in the serodiagnosis of brucellosis in vaccinated cattle under field conditions.

STUDY DESIGN

ANIMALS

Three herds consisting of adult and calfhood vaccinated animals were used for this study. Herd A was a registered beef herd and contained 387 animals at the time B. abortus was diagnosed. During a 16 month period prior to the start of this study, the herd experienced 87 reactors. Herd B was a Holstein herd containing 551 animals at the time of diagnosis of infection. Sixty-eight reactors were removed from the herd during the five month period prior to this study. Herd C was part of a commercial beef herd containing 263 animals. Sixty-nine animals were removed as reactors at the time of adult vaccination.

ANIMAL MANAGEMENT

All cows were inoculated subcutaneously with .5x10⁹ Strain 19 Brucella abortus organisms. Serum from all cattle was studied by the ACF and Card test at every test period. The Rivanol test was only performed on Card positive animals. The ELISA was first used in Herd A fourteen months post vaccination. All animals were retested at monthly intervals. Herd B was first tested with the ELISA 120 days after vaccination and retested at monthly intervals. Herd C was initially tested with the ELISA on the day of vaccination and retested at monthly intervals resuming 120 days later. Cows in Herds A and C showing suspect titers to the ACF were separated from the herd. Animals suspect or positive to the ELISA were further isolated. Conversely, ELISA suspects in Herd B were inadvertently left with the herd for three months after the resumption of testing. Herds A
and B were studied over a period of twelve months. Herd C studies encompassed a five month time period. When available, lymph nodes were collected on slaughtered animals. Selected cows remaining in the herd were milked for culture assays. Culled cows were made available by owners for possible lymph node culture assays.

CULTURE TECHNIQUES

MILK

Udders were washed and dried prior to milking. All quarters were milked and milk pooled as a composite sample in a whirl pack. Each specimen was immediately stored in ice until received at the laboratory. Specimens were assayed by the State/Federal Laboratory, Texas Animal Health Commission, Austin, Texas according to the procedures utilized by the National Veterinary Services Laboratory in Ames, Iowa except Farrels media was substituted for W media.

LYMPH NODES

The suprapharyngeal, mandibular, supra-mammary and internal ileac lymph nodes were removed. All tissues were packed in whirl packs and stored immediately in ice until received at the laboratory. Lymph nodes were removed from surrounding fat, dipped in alcohol, flamed, sliced and placed in sterile physiological saline. Solid and liquid materials were separated by a stonmacher. The liquid portion was assayed in the same manner as milk.

CONVENTIONAL SEROLOGICAL TESTS

The Card and Rivanol tests were performed by the State/Federal Laboratory, Texas Animal Health Commission, Austin, Texas and interpreted as prescribed in the Uniform Methods and Rules.

AUTOMATED SEROLOGICAL TEST

The Technicon Auto Analyzer II, located at the State/Federal Laboratory, Texas Animal Health Commission, Austin, Texas was used for Automated Complement Fixation tests (ACF). A detailed description of reagents may be found in the Technicon Instruction Manual on “Automated Complement Fixation Testing.” Diagrams of equipment and flow of serum and reagents have been pictured in detail. ACF results were interpreted according to the following standard: 20+ or greater = reactor, 10+ = suspect, and 5+ or less = negative.

ENZYME-LINKED IMMUNOSORBENT ASSAYS

The enzyme-like immunosorbent assay (ELISA) was performed in the Brucellosis Laboratory, College of Veterinary Medicine, Texas A & M University and by the State/Federal Laboratory, Texas Animal Health Commission, Austin, Texas. Equipment utilized for these studies were manufactured by Dynatech, Alexandria, Virginia. This equipment consisted of the following: Dynatech MR 600 microplate reader, Dynatech
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Microshaker, Dynawasher II, dynadrops dispenser and Immulon II microtiter plates. Standards for the ELISA are as follows: Spectrophotometric absorbance values (SAV) 0.000 to 0.599 = negative, SAV 0.60 to 0.999 = suspect and SAV 1.00 or greater = positive. A detailed description of reagents and procedures are described by Heck. 2, 4

RESULTS

Culture positive isolates from all cattle were identified as Bio Type I. Three positive isolates were made from lymph nodes of 11 cattle in Herd A. Thirty-five positive isolates were made from 42 cattle in Herd B. Thirty-one of these isolates were recovered from lymph nodes. Two animals from Herd C were available for culture assays. Both animals were culture positive on lymph nodes.

Table I summarizes the use of ELISA and ACF serodiagnostic tests in Herds A and B to predict *B. abortus* infection in cows previously negative on all tests. Five animals became positive on the ELISA and ACF tests simultaneously. Two of these animals were available for culture assays and were culture positive. ELISA tests were positive 30 to 65 days prior to ACF tests in 12 animals. All animals were culture positive for Field Strain. Five animals were positive to ELISA tests greater than 120 days prior to ACF tests. Three animals were available for culture assays and all were culture positive.

Six animals not shown on Table I were ELISA positive 38 to 120 days prior to slaughter. Four of the six animals showed only suspect titers to the ACF test at time of slaughter. Two animals were negative on the ACF as well as conventional tests at time of slaughter. All six animals were culture positive to Field Strain *B. abortus*.

Table II compares the ELISA and ACF tests in predicting brucellosis in two calfhood vaccinated virgin heifers shown in Herd A.

Heifer No. 144 was negative on the ACF test 60 days after initial testing. Thirty days later ACF antibody activity was demonstrated. The animal became serologically positive 210 days after initial test. Conversely, the ELISA was positive at the initial test and remained so until she was slaughtered in April. This heifer's dam was infected with *B. abortus* but it is unknown whether the cow was infectious at parturition. Heifer No. 207 demonstrated detectable ACF antibodies 30 days after the initial test and subsequently went seropositive 180 days later. No. 207, like 144, was ELISA positive on the initial test 210 days prior to the ACF test. This heifer's dam currently shows no evidence of brucellosis.

Table III summarizes the occurrence of false positive ELISA in cattle initially negative on all tests. Ten culled animals with negative ELISA and ACF serodiagnostic tests were culture negative after slaughter. Eleven animals were ELISA positive on one test and one animal was ELISA positive on two tests. Three of these animals were cultured after slaughter with negative culture assays. Nine animals were negative on milk cultures. Conversely, all animals who were seronegative on initial
tests and showing three or more ELISA positive tests, were culture positive.

Herd B was initially tested with the ELISA and ACF tests, 120 days after adult vaccination. Thirty-eight animals showed positive ELISA and ACF titers and were slaughtered. Of these animals, lymph nodes from 13 cows were cultured and 11 Field Strain isolates were made.

Twenty animals were found to be ELISA positive and ACF negative at the 120 post vaccination test. Thirteen animals eventually went negative on ELISA during a 210 day test period. None of these animals were positive on the ACF at any time period. All animals were negative on milk culture assays. Conversely, seven animals were subsequently positive on the ACF in addition to the ELISA and were slaughtered. Four of these animals were culture assayed and demonstrated Field Strain isolates from lymph nodes. The last culture positive animal was removed from Herd A seven months after initiation of this study. Herd B showed negative ELISA and ACF titers five months later.

Herd C had 38 ELISA suspect and positive animals at the time of adult vaccination. At the 120 day post vaccination test, fourteen animals were classified as reactors on the ELISA and ACF tests as well as conventional tests. Four of these seropositive animals were from cows previously negative to the ELISA and ACF test. Conversely, ten seropositive animals were out of the ELISA suspect herd.

DISCUSSION

The results of this study indicate that the ELISA is more sensitive than the ACF test in detecting antibody activity in vaccinated animals infected with Field Strain *B. abortus*. Twelve cattle negative to the ELISA on initial tests, showed positive ELISA titers 30 to 120 days prior to positive ACF tests. Five animals tested positive on the ELISA more than 120 days prior to becoming positive on the ACF test. Five animals became positive to the ELISA and ACF tests during the same test period. Furthermore, six animals that were ELISA positive 30 to 120 days prior to slaughter, were either negative or suspect to the ACF test at time of slaughter. Of these 28 animals, 23 were cultured and showed positive assays to Field Strain *B. abortus*.

Two virgin heifers from Herd A infected with *B. abortus* demonstrated ELISA positive titers 210 days prior to the ACF. If further studies confirm this observation with significant numbers of cattle, the ELISA test will be an important management tool in removing latent infection heifers from herds infected with *B. abortus*.

Animals positive on a single test with the ELISA did not help in predicting infection with any reliability. Conversely, animals previously negative to ELISA that showed positive ELISA titers three or more times yielded Field Strain positive culture assays.

Animals previously negative on all tests that became positive to the ELISA and later to the ACF test were found to be culture positive to Field
Strain *B. abortus*. Conversely, 13 cows in Herd B that were initially positive only on the ELISA test and subsequently went negative were negative on culture assays. These animals never attained positive ACF titers. Seven additional animals that were initially ELISA positive subsequently went ACF positive. Four of these animals were culture positive. It has not been determined whether these animals were infected at the 120 days test or at a later time. This uncertainty stems from an inadvertent lack of isolation of suspects. Antibody activity detected by the ELISA, at the 120 day post vaccination test may be attributed to Strain 19 vaccine administered previously.

Of the 38 ELISA suspect and positive animals in Herd C, 10 (26%) were serologically positive on all tests 120 days post vaccination. Conversely, 156 animals demonstrating negative titers at the time of adult vaccination subsequently showed four reactors. The ELISA predicted 71% of total reactors as was yielded 120 days post vaccination.

This study shows that the use of the ELISA as an early indication of infection, when confirmed by the ACF test, gives the Epidemiologist a valuable serodiagnostic tool in the management of Brucellosis.

Studies are currently in progress to further investigate the efficacy of ELISA tests in latent calfhood infection, pre-adult vaccination and post-adult vaccination.

ACKNOWLEDGMENTS

The author is grateful to Mary Menn, Roger Brasfield, and Rick Nabors, State/Federal Laboratory, Austin, for their laboratory support. The author is also grateful to Dr. Fred Heck, Texas A & M University, for technical and laboratory support. Special thanks to Dr. S. J. McConnell, Texas A & M University, for his longtime friendship and valuable assistance in preparation of this paper.

ELISA tests conducted by the Texas Animal Health Commission were performed with equipment and reagents generously furnished by Vicki A. Wallshein, International Product Manager for Dynatech Corporation Laboratories and Medical Products Group.

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2. Heck, F. C., Deyoe, B. L. and Williams, J. D., Antibodies to Brucella Abortus in Sera from Strain 19 Vaccine and Non-vaccinate Cows as Determined by Enzyme Linked Immunoabsorbent Assay and Conventional Serologic Methods, Veterinary Immunology and Immunopathology, 3, 1982, 629–634.


TABLE I

USE OF ELISA & ACF SERODIAGNOSTIC TESTS TO PREDICT BRUCELLA ABORTUS INFECTED ANIMALS

(Herds A and B)

Testing at monthly intervals

<table>
<thead>
<tr>
<th>ELISA=ACF</th>
<th>ELISA&gt;ACF*</th>
<th>ELISA&gt;ACF**</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 (2*)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>12 (12*)</td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>5 (3*)</td>
</tr>
</tbody>
</table>

* Positive ** greater than 120 days prior
( ) # animals cultured " 30 to 65 days prior

TABLE II

COMPARISON OF ELISA AND ACF TESTS IN PREDICTING BRUCELLOSIS IN TWO VIRGIN HEIFERS

(Herd A)

Seroconversion

<table>
<thead>
<tr>
<th>(144) ACF</th>
<th>(207) ACF</th>
<th>(144) ELISA</th>
<th>(207) ELISA</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>N</td>
<td>1.26</td>
<td>1.23</td>
</tr>
<tr>
<td>N</td>
<td>N</td>
<td>1.19</td>
<td>1.23</td>
</tr>
<tr>
<td>5+</td>
<td>5+</td>
<td>1.11</td>
<td>1.09</td>
</tr>
<tr>
<td>10+</td>
<td>5+</td>
<td>.83</td>
<td>1.07</td>
</tr>
<tr>
<td>10+</td>
<td>5+</td>
<td>1.22</td>
<td>1.15</td>
</tr>
<tr>
<td>10+</td>
<td>5+</td>
<td>1.35</td>
<td>1.35</td>
</tr>
<tr>
<td>20+</td>
<td>5+</td>
<td>1.31</td>
<td>1.26</td>
</tr>
<tr>
<td>N</td>
<td>10+</td>
<td>1.21*</td>
<td>1.16*</td>
</tr>
<tr>
<td>N</td>
<td>10+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5+</td>
<td>10+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5+</td>
<td>10+</td>
<td></td>
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</tr>
<tr>
<td>5+</td>
<td>10+</td>
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<td></td>
</tr>
<tr>
<td>10+</td>
<td>10+</td>
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<td></td>
</tr>
<tr>
<td>40+</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


* Field Strain isolated from calf on last test.
N = negative _____ = positive
**OUTBREAKS OF BRUCELLA ABORTUS**

**TABLE III**

**OCCURRENCE OF FALSE POSITIVE ELISA CATTLE**

<table>
<thead>
<tr>
<th>Control Animals</th>
<th># Times ELISA Positive</th>
<th>Culture Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0 0 0</td>
<td>10*(10)</td>
</tr>
<tr>
<td>ELISA False Positive Animals</td>
<td>11 1 0</td>
<td>3*(3) 9**(9)</td>
</tr>
</tbody>
</table>

*Lymph node cultures from these animals were negative.

**Milk samples collected from 9 animals were negative.

( ) # animals cultured.*
TABLE 4. Test results of heifers experimentally infected orally with *M. paratuberculosis*.

Each column represents 30 days. Exposure was at column one.

| Heifer 335 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Fecal Culture | - | - | - | - | - | - | - | - | - | 0  | -  | +  | -  | +  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| ELISA      | - | - | - | - | - | - | - | - | N | 0  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Lymph node culture | - | - | - | - | - | - | - | - | N | 0  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Fetal tissue culture | - | - | - | - | - | - | - | - | N | 0  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Intravenous Johnin | - | - | - | - | - | - | - | - | N | 0  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |

Heifer 336

| Heifer 336 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Fecal culture | - | - | - | - | - | - | - | - | + | 0  | -  | -  | 0  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| ELISA      | - | - | - | - | - | - | - | - | + | 0  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Lymph node culture | - | - | - | - | - | - | - | - | + | 0  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Fetal tissue culture | - | - | - | - | - | - | - | - | N | 0  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Intravenous Johnin | - | - | - | - | - | - | - | - | N | 0  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |

Heifer 348

| Heifer 348 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Fecal culture | - | - | - | - | - | - | - | - | - | 0  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| ELISA      | - | - | - | - | - | - | - | - | + | 0  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Lymph node culture | - | - | - | - | - | - | - | - | + | 0  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Fetal tissue culture | - | - | - | - | - | - | - | - | N | 0  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| Intravenous Johnin | - | - | - | - | - | - | - | - | N | 0  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |

0 = No data
- = not reported (Elisa)
N = negative (-)
+ = reaction
P = positive
S = suspect
SWINE BRUCELLOSIS — A VANISHING DISEASE

G. H. Frye, D.V.M.
Hyattsville, MD

In 1914, Traum made the first reported isolation of brucella from aborted swine fetuses collected in northern Indiana. It is not inconceivable that by 1989, the seventy-fifth anniversary of Traum's discovery, that \textit{Brucella suis} will have been eradicated from the United States. This paper broadly reviews some of the history and some of the milestones that have marked the transition of swine brucellosis from a newly recognized disease to one which may soon vanish from our swine population.

EARLY HISTORY

Traum believed that the organism he isolated in 1914 was \textit{Brucella abortus}. In 1916, Good and Smith isolated brucella from aborted fetuses in Kentucky, which, according to the methods then available, was also identified as \textit{B. abortus}.\footnote{1} These cultures were used to satisfy Koch's postulates, thereby, proving beyond doubt that brucella was infectious for swine. Later the cultures of Traum and those of Good and Smith were found to be \textit{B. suis}.

Early investigators observed that cultures from swine produced gross changes in guinea pigs that were different in character and size than those produced by cultures from bovine tissues. However, the organisms isolated from swine continued to be classified as \textit{B. abortus} until 1928 when laboratory methods to differentiate between isolations from cattle and from swine were developed.

The annual reports of the United States Animal Health Association (USAHA) and its predecessor the United States Livestock Sanitary Association (USLSA) quite graphically portray the early confusion that surrounded swine brucellosis and then the steadily expanding knowledge and understanding of the disease that followed. Much of the following historical information was derived from those published proceedings.

In 1918, the USLSA Committee on Infectious Abortion stated that there was sufficient evidence to warrant the conclusion that brucellosis was a dangerous communicable disease of cattle, and possibly swine, if not other domestic animals. This is the earliest recorded mention of swine brucellosis by this organization. The following year the Committee concluded that cattle were the natural host of the parasite but that it might live in hogs in which it was being reported as a cause of abortion.

In the succeeding years, an increasing number of papers were presented at the annual meetings of the USLSA on the problem of swine brucellosis. These reflected a growing awareness of the economic loss the disease was causing to the industry and also to the relationship it had to undulant fever in man.
EARLY INCIDENCE

As knowledge of swine brucellosis improved, the disease was reported with ever greater frequency from all sections of the country. In 1928, veterinary practitioners listed swine abortion as the fifth most important cause of production losses in hogs during the preceding season. Two years later 4.5 percent of the Iowa sows tested during a slaughter survey reacted to the agglutination test. Another Iowa survey covering all classes of swine showed 2.5 percent to be reactors. A study by Bock and Carpenter found slightly less than 2 percent reactors in hogs from States to the east and south of Iowa; they also reported that 0.2 percent of the hogs in New York reacted to the brucellosis test. In still another survey, Weiter found 20 percent of the sows and 7 percent of the barrows were reactors at dilutions of 1:50 or above.

The Committee on Transmissible Diseases of Swine in 1939 and 1940 reported swine brucellosis was on the increase and becoming "a real problem in some droves." It concluded that the apparent increase might actually be due to greater recognition of the disease through application of more extensive laboratory testing. This conclusion was equally applicable to brucellosis in man where the occurrence of undulant fever during this period was directly related to measures taken for its recognition.

BRUCELLA SUIS INFECTION IN MAN

Until the mid-1920's, undulant fever was a medical curiosity in the United States which physicians frequently misdiagnosed as an atypical form of typhoid. In 1924, Keefer\(^2\) made an isolation from the blood of a patient which was later identified by Evans\(^3\) as \textit{B. abortus}. Subsequent study in other laboratories showed the strain was actually \textit{B. suis}. This isolation by Keefer was recognized as the first proven human case due to the porcine type of \textit{Brucella}.\(^4\)

As physicians became more aware of undulant fever, the number of reported cases increased rapidly; in 1928, for example, there was a fivefold increase over the number reported in 1927. Initially, cattle were thought to be the chief source of infection but swine soon were being incriminated in over half the cases diagnosed. In 1928, Huddleson reported that 25 of the 46 isolates from man (the majority of those isolated up to that time) which were not \textit{B. melitensis} were the swine type.\(^5\) Since investigators at that time commonly misidentified \textit{B. suis}, type III, as \textit{B. melitensis}, the actual number of cases due to \textit{B. suis} was even higher than recorded. Hardy reported that two-thirds of the isolations from man in Iowa were \textit{B. suis}. The large number of diagnosed cases of undulant fever in Iowa each year was attributed not only to a high incidence of disease in its 10 million swine but also to the success of a campaign by the State Department of Health to educate medical practitioners about brucellosis.

Reported cases of undulant fever reached a peak of 6,321 in 1947. The number of reported cases has declined steadily since that time to the present level of about 250 annually. During the period 1959 to 1974, swine
were the most common source of human brucellosis; they still remain the most common source in packinghouse workers.

EARLY EFFORTS TO CONTROL SWINE BRUCELLOSIS

Efforts to control brucellosis in swine were at first hampered by the limited knowledge that was available and later by attempting to control the disease by the same methods developed for brucellosis in cattle. As early as 1920, control work in individual swine herds was taking place in California, Indiana, Missouri, Kentucky, and Illinois. As the prevalence of the disease, its economic importance, and its relationship to undulant fever became more apparent, so, too, did the need for a more systematic approach to its control. In 1931, the Committee on Transmissible Diseases in Swine recommended that a special committee be appointed to study methods to control and eradicate the disease and to recommend a plan for its eradication in breeding and farm herds.

Although a Federal cattle brucellosis program was initiated in 1934, another 25 years would pass before a national effort to control the disease in swine would officially get underway. During this period, individual States adopted a variety of control measures of their own. In 1946, Illinois Plan No. 1046 provided free laboratory testing toward the establishment of brucellosis-free accredited swine herds. This was a first step in reducing the State’s estimated 11 percent infection rate. In 1948, California began to certify herds as free of swine brucellosis as evidenced by two consecutive tests not less than 30 days apart with recertification by an annual negative test. Iowa adopted a similar plan 1 year later. Additional States instituted various other testing requirements leading to designation of swine herds as free of brucellosis.

In 1949, the USLSA Committee on Brucellosis recommended passage of Federal and State legislation to carry out a program to control brucellosis in both cattle and in swine. The recommendations on swine came out of a meeting of researchers sponsored by the United States Bureau of Animal Industry in the spring of 1949. Participants at this meeting agreed that sufficient information was available to justify complying with requests from swine raisers for official plans for control and eradication of brucellosis from swine. By 1954, 13 States had testing programs and herd certification programs. Eight States also had brucellosis requirements covering sales, exhibitions, and the movements of swine.

Uniform plans for the control of brucellosis in individual swine herds were adopted in 1958. This was followed in 1962 by the adoption of plans for the establishment and maintenance of Validated Brucellosis-Free areas. These guidelines were used by Dooley County, Georgia, to become the first validated county in 1962 and by Vermont to become the first validated State in 1964. With some additions and modifications these area and herd plans are essentially the same as those used in the program.

THE ERADICATION PROGRAM

Nineteen hundred and sixty-one could be called the pivoted year in the
control of swine brucellosis. It marked the end of a 40-year period of learning about the disease and of random efforts at controlling infection in individual herds and areas and the beginning of a unified national program to eradicate brucellosis from the Nation's swine population.

Although there had not been an organized program prior to 1961, a surprising amount of testing was going on around the country. In the 5-year period 1956 to 1960, over 88,000 herds with more than 700,000 swine were tested. This testing showed a herd infection rate nationally of 6.15 percent and an animal infection rate of 2.05 percent (Chart I). This testing period immediately preceded the start of the National Swine Brucellosis Eradication Program, and provides a baseline for evaluating progress since that time. Of the 42 States that carried out some level of testing during the period, only seven (Delaware, Maine, New Hampshire, West Virginia, New Mexico, Oregon, and Wisconsin) did not find infection. By contrast, in Fiscal Year (FY) 1982, the last full year when records are available, the herd infection rate was 0.39 on 37,000 herd tests with an infection rate of 0.18 in the 622,000 swine tested. Only 8 of the 48 States where testing occurred reported finding brucellosis.

Much of the progress in reducing swine brucellosis since 1961 can be attributed to an early decision to emphasize the validation of individual breeding herds. Seed stock producers were among the first to validate their herds and were those most likely to maintain their validation status year after year. Thus, the potential for spreading brucellosis via herd additions was reduced significantly from the very onset of the program. By 1974 over 4,300 breeding herds had achieved Validated Brucellosis-Free status, a number that has remained fairly constant since that time.

The reactor rate on slaughter surveillance samples is perhaps the best barometer of infection in the swine population as a whole. Since 1973 the reactor rate on sows and boars tested under the Market Swine Testing Program (MST) has declined from 0.08 to 0.039 in FY 1983. Because nonspecific reactions are common in swine, the true infection rate is undoubtedly even lower than the current MST rate (which is based on card test results) would indicate. Increased use of the rivanol test will help clarify the degree of nonspecificity that exists in current MST reactor data. Nationally, only about 40 percent of the card positive MST reactors are also positive when subjected to the rivanol test. The number of rivanol positive reactions generally showed a significant decline in FY 1982 (Chart II).

Starting with Vermont, a total of 25 States, Puerto Rico, and the Virgin Islands have achieved Validated Brucellosis-Free Area status (Chart III). Two of these States (Arkansas and Oregon) subsequently lost their validation status and have not been reinstated. In addition to the validated States, there are currently 9 States in Stage II and 11 in Stage I of the 3-stage validation program. Seven States are still in the no program category (Chart V). Characteristically, States that have eliminated their indigenous infection have remained free of the disease. This is in strong
contrast with the cattle brucellosis program where interstate spread is common. The low probability of spread has been an important factor in the success of the swine program to this point and enhances the probability that the infection that remains in the United States can be eliminated in a relatively short period of time.

A survey in July of this year showed only 41 swine herds under quarantine for brucellosis in the United States (Chart II). Thirty States reported that their last case had occurred over 5 years ago. An additional 13 States have not diagnosed swine brucellosis in more than 2 years (Chart II and IV). The failure to find infection in some nonvalidated States may be due, of course, to inadequate surveillance. However, most of these States do test a significant number of swine each year for change of ownership, export, shows, herd validation, etc.

We have made great strides since Traum's isolation of *Brucella suis* in 1914. We have learned about the disease, we have learned to control it, and we have reached the point where it soon could be eradicated. Swine brucellosis in this country is truly a vanishing disease, but it has not yet vanished. There is still work to be done; how soon we actually reach the vanishing point of the disease Traum discovered is up to us.

5. Report of Committee on Swine Diseases, Proceedings Thirty-Second Annual meeting of U.S. Livestock Sanitary Assoc., p. 621
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*Out of State  NR = None Reported
# A VANISHING DISEASE

Swine Brucellosis
Validated Brucellosis - Free States
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Swine Brucellosis
Time Since Last Known Infected Herd
Chart IV

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<td>*Wyoming</td>
<td>*Montana</td>
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<td>*Pennsylvania</td>
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<td>Nebraskap</td>
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<td>*Rhode Island</td>
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<td>New Mexico</td>
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<td>S. Carolina</td>
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<td>*N. Dakota</td>
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<td>*Puerto Rico</td>
<td>*Texas</td>
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<td>W. Virginia</td>
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<td>*Wisconsin</td>
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<td></td>
<td>*Virgin Islands</td>
</tr>
</tbody>
</table>

* = Validated State
Swine Brucellosis

Program Stages—Sept. 30, 1983

Stage 3
(Validated-Free)

Stage 1

Stage 2

No Program
Continued progress has been made in most areas of the brucellosis eradication program this year. All indicators, including the number of newly infected herds disclosed, the number of infected herds under quarantine, and the market cattle reactor rates, declined during the year while the number of calves vaccinated increased. Part 78 of the Code of Federal Regulations was amended on January 12, 1983, to include changes made the previous year in the Uniform Methods and Rules.

Development of the Brucellosis Information System (BIS) has not progressed as rapidly as might be desired but it is now moving forward. By September 30, 1983, data entry equipment to support the BIS program has been supplied to 30 States. Although not all of these States had received the training necessary to use the BIS program by September 30, training is scheduled as quickly as possible after installation of the equipment. During Fiscal Year 1984 an additional 13 States are scheduled to be brought into this recordkeeping system. Equipment has already been ordered for several of these States for delivery during the next 60 to 120 days and authorizations are being requested for ordering the remaining sets of equipment needed to implement this year's goals.

All of these States will be utilizing Release I for entering data from herd, livestock market, and slaughter test records. The present goals are to complete the development of Release II for the above programs as well as for the brucellosis ring test (BRT) and vaccination records by April 1984 and for the balance of the system (epidemiology, indemnity, and certificates) by October 1984. These are ambitious goals but they need to be achieved as quickly as possible to realize the potential of the BIS program. Some difficulties have been experienced in trying to implement this system. Most of these can be categorized as minor inconveniences.

One way to minimize these problems is to install standard equipment and operating systems in all States. Unfortunately, in a few instances optional operating software packages have been installed and needed to be substituted by Harris representatives at a later date. The few instances of equipment failure have generally been corrected quickly after the trouble was located.

All information is estimated since close of the year statistics are not available.

SLIDE 1

Effective September 30, 1983, there were 15 Class Free States, 21 Class A, 8 Class B, and 3 Class C States. In addition, three States have two-area status approved; Wyoming is divided between Class Free and Class A and
Texas and Florida have both Class B and Class C areas. Massachusetts, Pennsylvania, Delaware, Vermont, and a part of Wyoming were added to the Free category during the year. A request for split status for Montana is pending completion of an investigation of a herd that does not appear to be field strain infection. The status of Arkansas was changed on August 1, 1983, from Class B to Class C. This was due to an increase in the number of infected herds that exceeded the 1.5 percent allowable for a Class B area. Measures are being taken to correct certain deficiencies and increase efforts that will move that State forward.

SLIDE 2

From 1977 through 1981, concern was expressed because the number of infected herds had not decreased even though additional resources were added to the program. While the number of infected herds was staying up, the market cattle reactor rate was declining. This was reflecting the efforts to reduce infection levels through accelerated programs. The first significant drop in infected herds started in 1982 when the total fell from 13,228 to 11,597. This decline continued through 1983 to a total of 9,823. The majority of this decrease can be attributed to the improvement of the brucellosis situation in most high incidence States. Class C States account for 6,309 infected herds, Class B had 3,059, and 447 more were found in Class A States. Only Texas and Arkansas showed increases for the year, however, both States continued to show a decline in their market cattle reactor rate. Fewer herds were depopulated than expected due to the unavailability of funds early in the year and cattle prices later in the year.

SLIDE 3

The distribution of infection remains similar to previous years with 89.4 percent of the nation’s infection occurring in nine States and 10.6 percent in the rest of the country. There are 31 States, each with less than 30 infected herds, accounting for 1.8 percent of the total. Ten States have between 30 and 300 each, making up 8.8 percent and eight States with 300 to 1,000 infected herds representing 55 percent of the total. Texas had 34.4 percent of the 9,823 infected herds disclosed.

SLIDE 4

Infection was disclosed in 272 dairy herds as a result of testing BRT suspicious herds. There were 3,369 suspicious ring tests of which 2,140 were blood tested. One hundred eighty seven infected herds were found in Class B and C States while 85 were disclosed in Class A States.

SLIDE 5

The number of cattle tested under the Market Cattle Identification (MCI) program increased by 800,000 from last year to 13.1 million, 44.4 percent of which were tested at packing plants and 55.6 percent were tested at livestock markets and other locations. The market cattle reactor rate declined from 0.41 percent last year to 0.38 percent in 1983. This
reduction can be attributed to improvements in Class B and Class C States. Reduced dosage vaccine could have a significant impact on the MCI reactor rate in future years by reducing the number of reactors that are vaccine related.

SLIDE 6

Total cattle tested during 1983 were approximately the same as tested during 1982, although fewer cattle were tested on farms and ranches. This drop was due to the lower number of infected herds and infected herd tests. The total number of reactors found on farms and ranches was down by 20,000 from 1982, reducing the amount of indemnity payments during the year. The number of reactors found under the MCI program was the same as the previous year but the number of cattle tested was up.

SLIDE 7

The upward trend in calfhood vaccination continued in 1983 to a total of 8.1 million calves. This is an increase of 600,000 over last year. Much of the increase was in high incidence States where special emphasis is being placed on this part of the program. Over 1 million heifers were vaccinated in Texas this year.

SLIDE 8

The total number of swine tested for brucellosis in FY 1983 was 2.7 million; a slight decrease from the 2.8 million that were tested in FY 1982. Included in the total is 2.1 million tested at slaughter under the Market Swine Testing (MST) program and 651,000 tested on farms.

SLIDE 9

The reactor rate on all tests declined from 0.078 in FY 1982 to 0.058 in FY 1983. This reflects a drop in the on-farm rate from 0.21 to 0.12, and the MST rate from 0.046 to 0.039 during the year.

SLIDE 10

Two States, Alaska and Indiana, qualified for Stage III or Validated Brucellosis-Free Area status in FY 1983, bringing to 25 the number of States that have attained this goal.


Nine States, Alabama, Arkansas, Connecticut, Georgia, Hawaii, Illinois, Louisiana, New York, and Virginia were in Stage II. Eleven States, Florida, Kansas, Kentucky, Massachusetts, Michigan, Nebraska, New Jersey, North Carolina, Ohio, Oklahoma, and South Carolina were in Stage I, with one State, Nebraska, having advanced into this category.
during the year. Seven States, Mississippi, Missouri, New Mexico, Oregon, Tennessee, Texas, and West Virginia remained in the “No Program” classification at the end of the year.

SLIDE 11

There was a slight decline in the number of validated herds from 4,488 at the end of last fiscal year to 4,380 at the end of FY 1983.

The feasibility of a proposed swine surveillance program based on testing only boars at slaughter is still being studied. A major problem in this study is that too few infected herds have been available to make a valid determination of how effective the boar would be as a sentinel animal. We will continue to collect data for this project during FY 1984.
Cattle Brucellosis State Classifications

Sept. 30, 1983
### Brucellosis Eradication

#### Number of Infected Herds Found (According to State Classification)

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Certified-Free</th>
<th>Modified Certified</th>
<th>Noncertified</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976</td>
<td>16,362</td>
<td>13,917</td>
<td>13,507</td>
</tr>
<tr>
<td>1977</td>
<td>14,293</td>
<td>13,254</td>
<td>11,307</td>
</tr>
<tr>
<td>1978</td>
<td>14,507</td>
<td>12,320</td>
<td>11,254</td>
</tr>
<tr>
<td>1979</td>
<td>13,507</td>
<td>12,754</td>
<td>10,254</td>
</tr>
<tr>
<td>1980</td>
<td>12,754</td>
<td>11,324</td>
<td>8,309</td>
</tr>
<tr>
<td>1981</td>
<td>11,324</td>
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<td></td>
</tr>
<tr>
<td>1982</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1983*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### State Classification

- Certified-Free
- Modified Certified
- Noncertified

#### New State Classification (Effective May 1, 1982)

- Class Free
- Class A
- Class B
- Class C

#### Number of States in Each Classification (before May 1982)

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Certified-Free</th>
<th>Modified Certified</th>
<th>Non-Certified</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976</td>
<td>28</td>
<td>22</td>
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<tr>
<td>1977</td>
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<tr>
<td>1978</td>
<td>27</td>
<td>23</td>
<td>0</td>
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<tr>
<td>1979</td>
<td>30</td>
<td>20</td>
<td>0</td>
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<tr>
<td>1980</td>
<td>31</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>1981</td>
<td>32</td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td>1982</td>
<td>32</td>
<td>18</td>
<td>0</td>
</tr>
</tbody>
</table>

#### New Classification

- Class Free
- Class A
- Class B
- Class C

<table>
<thead>
<tr>
<th>Year</th>
<th>Class Free</th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>16</td>
<td>22</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

*States with dual status
- Wyoming—Class Free and Class A
- Texas and Florida—Class B and Class C

*Estimated
Brucellosis Eradication

Percent of Total Reactor Herds Found

**Fiscal Year 1983**
*Total Herds: 9,823*

- **34.4%**  
  States: 1  
  Herds: > 1,000  
  Total Reactor Herds = 3,381

- **1.8%**  
  States: 31  
  Herds: < 30  
  Total Reactor Herds = 174

- **8.8%**  
  States: 10  
  Herds: 30 < 300  
  Total Reactor Herds = 861

- **55.0%**  
  States: 8  
  Herds: 300 < 1,000  
  Total Reactor Herds = 5,407

*Estimated
Brucellosis Eradication

Milk Ring Test Results (BRT)

- Total Suspicious BRT Tests
- Follow-up Herd Blood Tests
- Infected Herds Found

*Estimated
Brucellosis Eradication

Market Cattle Testing Program

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>At Packing Plants</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>63.3%</td>
<td>36.7%</td>
</tr>
<tr>
<td>1974</td>
<td>60.6%</td>
<td>39.4%</td>
</tr>
<tr>
<td>1975</td>
<td>70.0%</td>
<td>30.0%</td>
</tr>
<tr>
<td>1976</td>
<td>69.6%</td>
<td>30.4%</td>
</tr>
<tr>
<td>1977</td>
<td>67.5%</td>
<td>32.5%</td>
</tr>
<tr>
<td>1978</td>
<td>62.2%</td>
<td>37.8%</td>
</tr>
<tr>
<td>1979</td>
<td>54.8%</td>
<td>45.2%</td>
</tr>
<tr>
<td>1980</td>
<td>41.7%</td>
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</tr>
<tr>
<td>1981</td>
<td>42.0%</td>
<td>58.0%</td>
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<tr>
<td>1982</td>
<td>44.4%</td>
<td>55.6%</td>
</tr>
<tr>
<td>*1983</td>
<td>43.3%</td>
<td>56.7%</td>
</tr>
</tbody>
</table>

*Estimated

Millions of Cows Blood Tested

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Brucellosis Eradication

Blood Testing: Cattle

- **Farm or Ranch**
- **MCT**

**Millions Cattle Tested**
- 30

**Thous. Reactors Found**
- 300

- 1973: 13.6
- 1974: 14.6
- 1975: 17.7
- 1976: 22.0
- 1977: 20.8
- 1978: 20.8
- 1979: 17.6
- 1980: 17.8
- 1981: 19.5
- 1982: 19.4
- 1983: 19.3

**Fiscal Year**
- 1973: 158
- 1974: 196
- 1975: 250
- 1976: 283
- 1977: 236
- 1978: 241
- 1979: 197
- 1980: 155
- 1981: 183
- 1982: 176
- 1983: 156

*Estimated*
Brucellosis Eradication

Calves Vaccinated

Millions

0 2 4 6 8

1956 58 60 62 64 66 68 70 72 74 76 78 80 81 82 83

Fiscal Year

*Estimated.
Swine Brucellosis
Animals Blood Tested

Thousands of Animals Tested:

- 5,500
- 5,000
- 4,500
- 4,000
- 3,500
- 3,000
- 2,500
- 2,000
- 1,500
- 1,000
- 500
- 0

Years:
- 1975
- 1976
- 1977
- 1978
- 1979
- 1980
- 1981
- 1982
- 1983

*Estimated Fiscal Year

Graph indicates the number of animals tested for swine brucellosis blood samples from 1975 to 1983. The data shows a decrease in the number of animals tested over the years, with an estimated fiscal year in 1983.
Swine Brucellosis
Infection Rate

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Tests</th>
<th>On Farm</th>
<th>MST</th>
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<tbody>
<tr>
<td>1975</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1976</td>
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<td>1982</td>
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<tr>
<td>1983*</td>
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</tbody>
</table>

*Estimated Fiscal Year
Swine Brucellosis

Program Stages—Sept. 30, 1983

Stage 3
(Validated-Free)

Stage 1

Stage 2

No Program

Map of the United States showing the program stages for swine brucellosis as of Sept. 30, 1983. States are color-coded to indicate their stage of the program.
Swine Brucellosis
Validated Herds FY 1983*

*Validated Herds FY 1983

State of Territory

None
1-25
26-100
Over 100

Total Herds: 4380

*Estimated

- State-Federal Brucellosis Eradication Program
The meeting was called to order by Chairman John Armstrong at 1:30 p.m.

Chairman Armstrong announced that Dale Rodgers of New Mexico has been named to replace W.F. "Dub" Martin, New Mexico, on the committee. Dr. Fred Idtse has been appointed to replace Dr. W.F. Lyle, Wisconsin and Dr. Schmall has also been named to the committee.

Dr. Clarence Campbell, Florida, reported on the Florida program and stated the following recommendations:

1. All heifer calves born after July 1, 1984 be officially calfhood vaccinated to qualify for interstate shipment.

2. Herds which have achieved a Certified Brucellosis-Free status maintain such a status for a three-year, rather than a one-year period; provided, however, if a reactor is disclosed in those herds as a result of market cattle testing or other means, that usual testing would resume as quickly as possible in resolving the status.

3. That the committee consider the possibility of establishing "Provisional Certified Brucellosis-Free Herds". Such a herd, having at-
BRUCELLOSIS

obtained a certified status by the current existing method, might be re-certified by randomly testing annually a pre-determined number of cattle such as was used in 1959 UM&R.

No action was taken on Dr. Campbell's recommendations.

Dr. Billy Johnson reported on the national eradication program.

As of Sept. 30, 1983, there were 15 Class Free States, 21 Class A, 8 Class B, and 3 Class C states. In addition, Texas and Florida have two-area status—Class B and C and Wyoming is both Class Free and Class A. A request for two-area status for Montana is pending.

This year Massachusetts, Pennsylvania, Delaware, Vermont, and a part of Wyoming were added to the Free category. Arkansas was changed from Class B to Class C.

The MCI reactor rate continued to decline last year, with a slight increase in July and August due to increased marketings in the midwest.

In Classes A, B and C there has been an average 15% reduction in the number of infected herds from 1982 to 1983.

The complete status report on the program will be presented at the general session Thursday, October 20 at 11:30 a.m.

Dr. Johnson noted that a proposal will soon be published in the Federal Register relating to qualifying certified herds within a state under quarantine with fewer restrictions than other herds. He urged interested groups to comment.

USDA has contracted a firm that specializes in rewriting technical language to make it easier to read and understand. It is proposed that this be done to the UM&R.

The brucellosis eradication budget for FY 83 was $83.4 million. Tentative allocations that amounted to $75 million were made to the states in order to continue operating after the fiscal year. The continuing resolution that will be in effect until a final budget is passed sets the brucellosis budget at $69.5 million.

Dr. Francis Drazek, New York, discussed several unforeseen problems that were encountered in the eradication of brucellosis in New York.

Dr. Gary Adams reported for the Scientific Advisory Committee on the following items:

1. **Three year interval between tests for recertification following initial herd certification.**

   The Advisory committee does not support this.

2. **Inclusion of the Automated Complement Fixation Test in the UM&R and setting standards.**

   The Advisory committee recommends that the automated complement fixation test be adopted as an alternate to the manual CFT as a supplemental serologic procedure when used in conjunction with the present standard serological procedures for classification of animals as reactors;
however, the committee also recommends that further studies be performed to establish negative and suspect categories for the automated CFT.

If this recommendation is adopted, the Advisory committee further recommends that data accumulated during the next year be analyzed and reported at the 1984 USAHA meeting.

The committee interprets the data presented to clearly demonstrate that the manual CFT at 1:40 is not equivalent to the automated CFT at 1:20, but the automated CFT detects more culture positive cattle than the manual CFT.

(See Tuesday’s minutes—more data was presented)

3. **Release of adult vaccinated dairy herds based on individual milk ring tests as an alternative to a negative milk ring test for the herd.**

The Advisory committee requested clarification of this recommendation as no data or information was provided.

Raymond Schnell reviewed the effect of the current UM&R on officially vaccinated animals at markets near state borders. He introduced three representatives of markets in Mississippi that are affected by the regulations.

He recommended that the test 60 days before movement be dropped and the test 45-120 days post-movement be recommended for official vaccinated, to allow cattle to move to markets across state lines from a Class C state to another Class C state.

(See Tuesday minutes)

Chairman Armstrong discussed the Texas program. There has been a 24% increase in the number of animals tested, to the highest level in the history of the program. The MCI reactor rate dropped 10%. Forty percent of the heifer calves were vaccinated last year. There are 843 Certified-Free herds in the state, an increase of 71%, as of the end of September. Armstrong introduced Robert Bartlett, the new chairman of the Texas Animal Health Commission.

Dr. Gregg Nelson (reporting for the subcommittee of Drs. Hudelson, Nelson and Woods) reported on the differences between requirements in the CFR and the UM&R for cattle from Class B and Class C states moving to quarantined feedlots.

The basic difference is that the CFR allows movement interstate to a quarantined feedlot from a herd of origin and meet S brand requirements at destination—no test. The UM&R requires a test—if no test is made it requires an S brand and movement with permit.

The subcommittee recommended:

From Class A to quarantined feedlot - add: “if origin is maintained by means of identification tags, backtags, or brands.” From Class B and C - recommend wording in CFR be maintained and drop wording in UM&R that requires test. If states want such a test, they should cover it in state regulations.
The recommendation was moved, seconded and passed unanimously.

Dr. Roth reported for the subcommittee of Drs. Roth, Newcomb and Prichard on the reduced sensitivity of the BBA card test and its use in the field. After discussion, the subject was tabled until the Tuesday meeting.

Dr. D.E. Pietz commented on the above subject for the Scientific Advisory Committee.

The advisory committee recommends that the new reduced sensitivity card test antigen be used in livestock markets when: 1) the present card test is positive and only when 2) the animals are official adult or calfhood vaccinates.

Dr. Flagg reported for the subcommittee of Drs. Flagg, Cobb and Dick on the requirements of a Class free State following identification of an infected herd within the state. He discussed problems resulting from infection involving a bison herd. A case history is included as part of these minutes as Attachment #1.

Flagg recommended a change to the UM&R. It was moved, seconded and passed. The wording of the change appears in Attachment #2.

John Cargile reported for the subcommittee of Gallagher, Cargile and Dr. Walker on the suggestions about calfhood vaccination:

1. Restriction on future distribution and use of Strain 19 vaccine packaged as a “full,” “old” or high cell count dose.

The subcommittee recommended that the Brucellosis committee recommend that Chapter 1, Definition P, 1, b. (of the UM&R) be eliminated as of Dec. 31, 1984.

The recommendation was moved, seconded and passed by the committee.

2. All female cattle shipped interstate to be properly vaccinated as of July 1, 1984.

3. All heifer calves born after July 1, 1984 be officially calfhood vaccinated to qualify for interstate shipment.

The subcommittee addressed both 2 and 3. After discussing the advantages and disadvantages of each, the subcommittee recommended that:

a) A cost study be made of a national mandatory calfhood vaccination program for all heifer calves moving in interstate commerce.

b) A cost study be made of requiring that all female cattle moving in interstate commerce for breeding purposes be official brucellosis vaccinates.

c) States importing heifer calves from high brucellosis incidence areas require these calves to be brucellosis vaccinates.

d) High incidence areas require all female imported cattle be brucellosis vaccinates.

The cost studies should be completed and reported 30 days before the 1984 annual meeting of the USAHA and sent to brucellosis committee members.
Jack Dahl proposed a substitute recommendation: "All female cattle born after December 31, 1984 moving in interstate commerce, over 12 months of age, be official vaccinates except spayed heifers and those destined for quarantined feedlots and immediate slaughter." Dahl moved, second by Taylor Woods.

An amendment was proposed that would add "... or animals moving between Class Free states." Dahl and Woods agreed to the amendment.

Another amendment to the motion (to add Class A states to the exceptions) failed.

A vote on Dahl's motion (including the Class Free exception amendment) failed to pass.

The committee discussed the recommendations of John Cargile's subcommittee. After much discussion, it was agreed to add a statement stressing the importance of vaccination. The subcommittee will rewrite the recommendation for committee action at Tuesday's meeting.

A video tape produced by the Texas Farm Bureau was shown. It illustrated some problems encountered in testing and processing cattle in the Gulf Coast states.

Dr. Vanderwagen reported for the subcommittee of Drs. Vanderwagen, Cobb, Fairchild and Hudelson on states requesting a two-area classification. The review of Wyoming's request for Class Free and A areas and Montana's similar request was discussed. Wyoming has been granted two-area status and action on Montana is pending, depending on the result of testing an infected herd that was found in the proposed Free area. Dr. Newcomb reviewed the plan for Montana.

A motion to endorse the plans for both Wyoming and Montana was passed by the committee.

The committee session was adjourned until Tuesday, October 18, 1983 at 1:30 p.m.

Minutes of meeting—Tuesday, October 18, 1983

The meeting was called to order by Chairman Armstrong.

Dr. Paul Doby presented the report of the subcommittee on swine brucellosis and it was approved by the full committee. The complete report and recommendations of the subcommittee follows these minutes as Attachment #3.

John Cargile presented the rewritten recommendation concerning calfhood vaccination that was tabled from Monday's meeting. The following statement was presented:

"The Brucellosis Committee of the USAHA considers calfhood vaccination of all replacement female cattle, raised or purchased, going into the breeding and dairy herds in the Class B and C areas to be essential to the eradication of brucellosis. The development of an effective method of achieving a high level of vaccination in these heifers is a high priority of this
The following change in the UM&R reflects the intent of that statement: "Effective July 1, 1984 all female cattle born after January 1, 1984 and are over four months of age moving in or out of Class C areas must be official vaccinates, spayed heifers or S branded."

A motion to recommend the statement and the UM&R change was seconded.

Dr. John Cobb presented the following amendment to the motion: "All female dairy cattle born on or after January 1, 1984, four months of age or over, must after July 1, 1984 be official calfhood vaccinates to move into or out of Class A, B or C states."

The amendment was moved, seconded and passed by the committee.

The motion to accept the recommendation, including the amendment, passed.

Jack Dahl presented the report of the subcommittee of Dahl and Drs. Dierks and Ray.

A recommendation allowing future testing be accomplished with the option of a new ear tag applied to each test-eligible animal to simplify the testing procedure failed on vote of the committee. There was no recommendation from the subcommittee on that issue.

It was pointed out that an improved, readable, durable eartag would eliminate the need for inserting multiple ear tags and the problems associated with that.

The subcommittee moved that the proposal from NCA concerning an alternate site for the AV brand to be high on the hip, near the tailhead be approved. The motion was seconded and passed by the committee.

The subcommittee recommended the following change to the UM&R:

Chapter 1, Part 1, CC. Certificate—"... Ownership brands may be used as identification on certificates for cattle being shipped interstate where brucellosis or other official tests are not required, provided the ownership brands are registered with an official recording agency and are accompanied by official recording certificates."

The recommendation was moved, seconded and passed by the committee.

The identification subcommittee recommended the following change to the UM&R:

Chapter 1, Part II, Y. Identification of Spayed Heifers — "Spayed heifers may be officially identified by applying a hot iron brand to either or both jaws using an open spade design, as used in playing cards ( ), of not less than 3 inches high."

The recommendation was moved, seconded and passed by the committee.

Dahl proposed a recommendation from NCA that the brucellosis indemnity level be a flat rate of $50 for all cattle and bison. It was amended, with approval, to read "not more than $50." The motion failed on vote of the
committee.

Bill Knox reported for the subcommittee of Knox, and Drs. Hartin and Barton. The subcommittee presented the following recommendation for state classification standards for market cattle identification reactors.

It is recommended that APHIS monitor and measure the impact of low dosage vaccination and the less sensitive card test on the market cattle identification program. We further recommend that such data as are available by mid-1984 be provided a representative panel of 5 to 9 members, appointed by the chairman of this committee. That panel would be charged with the responsibility of making recommendations for changes in state classification standards for market cattle identification reactors. We further recommend that the panel's recommendations be submitted to the Brucellosis Scientific Advisory Committee for its review at least 60 days prior to the USAHA annual meeting. The report and review will provide the basis for definitive action by USAHA.

The recommendation was moved, seconded and passed by the committee.

Dr. Roth presented a recommendation on the reduced sensitivity of the BBA card test and its use in the field. This had been tabled at Monday's meeting. Before the vote, the authors agreed to a suggested amendment. The amended language is underlined:

The new buffered card test antigen with a sensitivity comparable to a positive reaction at the 1:25 dilution of the Rivanol test is desirable as a diagnostic test for livestock market testing. At the livestock market, testable cattle would be tested by the card test using the present Buffered Brucella antigen. If official vaccinated animals are positive, they would be retested with the new less-sensitive card test (pH 3.30). Vaccinated animals positive to the present card test and negative with the new antigen would be considered suspects and restrictions would not be placed on the balance of the animals. Confirmation testing at the State-Federal laboratory would be continued as prescribed in the UM&R. All such suspects would be returned to the farm of origin under quarantine or be S branded. If such suspects are not available for later testing and evaluation, the herd of origin must be placed under quarantine and tested. If the herd of origin doesn't exist, the tissues from the suspect animal shall be cultured for B. abortus. Further epidemiological investigation of the adjacent and other contact herds must be conducted to detect if infection is present. The extent of the investigation would be determined by the epidemiologist.

Animals positive to both card test antigens will be considered as reactors and all exposed animals shall be sent to slaughter or be returned to the farm of origin under quarantine.

It is recommended that this procedure be incorporated into the UM&R as soon as possible.

The use of this procedure in each state would be based on mutual acceptance by State-Federal officials.

As a follow-up, field studies on this procedure will continue throughout
the year and results reported at the 1984 USAHA meeting. Extensive data on vaccinated and non-vaccinated animals from negative populations must be included in this evaluation.

The recommendation passed as amended.

Dr. W.B. Fairchild reported for the subcommittee of Drs. Fairchild, Espe and Cole. They recommended a change in the UM&R that would establish a suspect classification for official vaccinates in the standards for the rivanol test. The Scientific Advisory committee did not support the recommendation. The recommendation was moved, seconded and passed by the committee. The complete wording appears as Attachment #4.

The report of the education subcommittee was presented by Sid Moore. The need to reach producers that are not affiliated with any organization was stressed. The education program developed by the Kerr Foundation was described and Jim Horne, of the Kerr foundation, showed slides about the program. The complete report of the subcommittee appears as Attachment #5 of these minutes. It was moved, seconded and passed by the committee to approve the report and its recommendations.

J.O. Pearce moved that there be a three-year interval between tests for recertification following initial herd certification. The motion failed.

Dr. Woods moved that the committee recommend the following study programs:

1. The Feasibility of qualified herd—increase of time for movement of cows interstate.
2. Feasibility of increasing the time for retest of certified herds in A,B and C states.
3. Feasibility of herd certification extension on dairy herds with use of BRT's.
4. Feasibility of moving of slaughter cows interstate “S” branded (may or may not be tested negative) to another state’s market before going to slaughter.

The motion was seconded and passed by the committee.

Dr. Alexander, Texas, presented a recommendation to include the Automated Complement Fixation Test in the UM&R and set standards. Dr. Gary Adams reported on behalf of the Scientific Advisory committee. These comments replace his recommendations at Monday’s meeting (see Monday’s minutes) as the committee did not have complete information at that time.

The Scientific Advisory Committee recommends that the automated complement fixation test (as conducted in Texas) be adopted as an alternate to the manual CFT as a supplemental serologic test when used in conjunction with the present standard serologic procedures for classification of animals.

Further, the committee recommends that Winthrop Ray of the Brucellosis staff of Veterinary Services, USDA, chair a committee com-
prised of: Ralph Cooper (CA), Joe Hendricks (SC), Jim Alexander (TX), Herb Wright (IA), Fred Heck (TX) and David Berman (WI) to evaluate the spectrum of automated and manual CF tests currently being used and recommend one automated and one manual CFT procedure for national standardized testing at the 1984 USAHA Brucellosis Committee meeting.

The recommendation presented by Dr. Alexander was moved by Dr. Holcombe, seconded and passed by the committee. The complete wording appears in Attachment #6.

It was also moved, seconded and passed that the study group named by Dr. Adams proceed as suggested and report at the 1984 brucellosis committee meeting.

Dr. Alley presented a recommendation for the release of adult vaccinated dairy herds based on individual milk ring tests as an alternate to a negative milk ring test for the herd.

Dr. Adams, speaking for the Scientific Advisory committee, suggested an amendment to the recommendation. The amendment would add all individual AV dairy animals in the milk ring test prior to release from herd quarantine. A vote on this amendment failed.

Dr. Alley agreed to an amendment that would include all lactating AV dairy animals. The recommendation, as amended, was passed by the committee. The complete wording follows:

UM&R Chapter 1, Part II. Procedures—Minimum Standards
R. Whole Herd Vaccination Plan
1., 2. & 3.

Dairy Herds—All of the foregoing shall apply to "AV" dairy herds. In addition, dairy herds shall either be negative to the last milk ring test or all individual lactating AV dairy animals shall have less than a 1:16 titer by the milk ring test on individual samples of all quarters prior to release from herd quarantine.

A recommendation, presented by Dr. Jim Badger, to change the UM&R Procedures, Minimum Program Standards, Herd Depopulation, failed on vote of the committee.

A recommendation by Dr. W. D. Prichard that each Class A and Class Free state should initiate legislation to obtain the authorities and to designate funds for the purpose of depopulation also failed on a vote of the committee.

Jack Dahl moved that the committee contact Dr. W. E. Lyle's family expressing appreciation for his work on the committee. Dr. Lyle passed away this year.

Jack Dahl presented a recommendation from the indemnity subcommittee:

Propose that maximum indemnity payment levels be reduced from FY 84 levels by 20% of that level annually. Indemnity payments would be zero by FY 89.
Also recommend that beginning in FY 85, no herd owner shall receive any indemnity following the initial herd test disclosing brucellosis unless he has initiated an approved herd plan.

The recommendation was moved, seconded and passed by the committee. Dahl moved that the committee support the National Brucellosis Task Force and its work for funding for research and development. The motion was seconded and passed.

Dr. Gregg Nelson presented a recommendation from the Western States Livestock Health Association. The recommendation would allow a statement to be placed on official health certificates certifying brucellosis vaccination status of female cattle and this statement be signed by the shipper. The motion failed on vote of the committee.

Dr. Gary Adams presented recommendations and concerns of the Scientific Advisory committee. The recommendations were tabled by the committee.

Raymond Schnell recommended a change in the UM&R to allow officially vaccinated cattle to move interstate from a B or C Class state to a like state on the basis of one negative test within 30 days of movement. The motion failed on vote of the committee.

Actions on other UM&R changes recommended by Schnell were tabled.

Dr. Joe Bitter moved that APHIS review the fee basis structure and come up with a new one to allow veterinarians to participate and support the program as they have in the past, based on the letter from the Texas Veterinary Medical Association that was circulated to the committee. The motion was seconded and passed.

The meeting was adjourned at 6:30 p.m.

A CASE HISTORY OF A BRUCELLOSIS OUTBREAK IN A BRUCELLOSIS FREE STATE WHICH ORIGINATED IN BISON

On July 14, 1983, five adult bison females and one adult bison bull, originating from a North Dakota ranch, were slaughtered at a plant in South Dakota. The following titers were found in blood samples collected from this consignment.

<table>
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<tr>
<th>Age</th>
<th>Sex</th>
<th>Card</th>
<th>SPT</th>
<th>Riv</th>
<th>Test</th>
<th>Inter.</th>
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</thead>
<tbody>
<tr>
<td>6 yrs.</td>
<td>F</td>
<td>+</td>
<td>+ 100</td>
<td>I 100</td>
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On July 26, the herd of origin; which consisted of 21 bison, was tested disclosing 18 reactors, 1 suspect, and 2 negative. All reactors were card
positive; with 16 being Rivanol positive in the 1–200, 1 positive in the 1–100, and 1 positive in the 1–25. Seventy-seven head of cattle on the same premises were tested and one beef cow reacted 1–200 on the Standard Plate Test, was card positive, and positive in the Rivanol 1–200. The herd of beef cows had contact with the bison to some extent during the winter months. All the bison and the reactor cow were slaughtered and tissues were collected and submitted for laboratory examination. B. Abortus Biotype I was isolated from 13 of the bison and the one reactor cow. The entire herd of cattle was depopulated September 13, 1983.

There are several facts concerning this case which should be pointed out. This bison herd had been in existence for approximately six years. No significant number of abortions were reported by the owner, but a very low conception rate existed for several years. All the beef cattle were tested in October 1982 and all were negative, including the reactor animal which was not vaccinated. One of the reactor bison cows was carrying an official South Dakota vaccination tag which was inserted at the time of vaccination on November 10, 1975. The herd in which this animal was vaccinated was known to be infected with brucellosis at that time. It is not known when this animal was added to the herd in North Dakota, but the owner estimated the time of purchase to be 1978 or 1979.

This information proves beyond any reasonable doubt that the disease originated in the bison, which should serve to emphasize the inherent danger infected bison can be to the cattle industry and to the success of the eradication program.

**UM&R CHAPTER 1, PART V. CLASS FREE STATUS**

**B. Length of Classification—Indefinite.** However, Free status is automatically suspended upon disclosure of field strain infection except when the field strain infection was found to be imported and no spread of brucellosis occurred prior to the immediate destruction or return of the exposed animals. Special consideration will be given for infection found later than 120 days when the quarantine was extended for additional tests and no opportunity occurred for the spread of exposed animals. States shall document program status by a 12 month special (annual) report. The special report shall disclose the following information:

**MINUTES**

Meeting of the Subcommittee on Swine Brucellosis of the Committee on Brucellosis of the United States Animal Health Association

The Subcommittee met October 17, 1983, in the Sahara Hotel, Las Vegas, Nevada, with the following members present: Paul Doby, Chairman; Neal Black, John Cobb, Robert Combs represented by Ronnie Pullen, Granville Frye, Merle Lang, David Meisinger and Phillip Pickerill.

The agenda was approved as proposed by the chairman, who called on
Dr. Granville Frye, Chief Staff Veterinarian, Cattle Diseases Staff, USDA, APHIS, VS, to report on the status of swine brucellosis and the program.

Frye reported that in fiscal year 1983, 2.7 million swine were tested, 2.1 million in the MST Program, and 651,000 on the farm. The reactor rate, based on card test positives, for those tests, was .058 percent. The on-farm reactor rate has dropped from .21 percent during the previous year to .12 percent, while the MST reactor rate dropped from .046 to .039 percent.

Frye said the data on the reactor rate, based on rivanol positives, was not available for 1983. His data on rivanol supplemental tests on card test positives for the previous year revealed there were 385 rivanol positives out of over three million head testing in the country.

Frye discussed data for 1982 nationally which indicated that there were 1,202 card positives, of which 1,036 were rivanol tested, with 385 rivanol positives, leading to testing in 71 herds, of which 25 were found to be infected. Seventy-four herds were tested on the basis of card positive, rivanol negative, and five infected herds were disclosed, all in Georgia.

Frye pointed out that 25 states are Validated Brucellosis-Free Areas. The number of validated brucellosis-free herds declined slightly during the past year, from 4,488 to 4,380.

Frye said the Subcommittee's request that the UM&R be changed to specify that only rivanol positives would be traced, has been implemented; however, the tracing of all card positives is encouraged in states where there is a problem. Dr. Cobb pointed out that rivanol negative tracing in Georgia has resulted in disclosure of infected herds so that state will continue to trace all card test positives.

Another request of the Subcommittee has not been implemented: that identification requirements be changed to eliminate the slap tattoo as an official identification method for boars and to require an externally visible means of identification. Frye stated that it would require an amendment to Part 78 CFR, since there is some question whether different identification methods could be specified for boars and sows. In response to a question, he indicated that if the regulations were required to specify testing of boars only, the official identification method could be changed by the Secretary of Agriculture.

Frye presented data relative to the field trial on identification of boars which indicated that 77 percent of the boars could be traced with certainty and an additional 20 percent were classified as "very likely" tracebacks, leading to the conclusion that "properly identified boars can be successfully traced to farm of origin."

Frye said the other aspect of the study, the effectiveness of the boar as a surveillance device, is being continued and the data is not yet sufficient on which to draw conclusions. The study is based on surveys in infected herds to determine whether or not the boars in such herds were infected at the time the herd was depopulated. There is an insufficient number of infected
herds from which to assemble the needed amount of data. Data was added on only 10 herds during the past year. Boars were found to be infected in 13 of the 26 herds on which usable data is available.

Frye said one interpretation of the data available for the last fiscal year indicated the ability to trace 44 percent of the reactors found in the MST Program, but he believes that percentage is high and a different analysis would show that it was not much higher during the past fiscal year than the 29 percent traced in a preceding year.

It was pointed out that the data on boar infection in infected herds might have been different if the herds had not been depopulated and there had been a greater opportunity for the boars to become infected.

Following a great deal of discussion, there was consensus within the Subcommittee that, even though only limited data is available on boars, if a high percentage of boars was identified and traced to farm of origin, concentration on surveillance of boars only would be more effective in discovering infected herds than the present program of testing both sows and boars, given the low percentage of identification and tracebacks in the current program.

The Subcommittee approved the following recommendation: that validated states may discontinue mandatory identification of sows as a monitoring device for swine brucellosis and in lieu thereof concentrate MST testing on boars. Passage of the recommendation was moved by Lang, seconded by Black and carried.

Doby called for reports from the seven states with no programs for eradication of swine brucellosis, with the following results:

Missouri—From July 1982 through June 1983, 18,547 swine were tested on the farm and 138,559 in slaughter plants in the state, with no reactors. It was estimated that this is about 20 percent of the sow population in the state. Dr. C. W. Monsees, the State Veterinarian, said he feels if 20 percent of the sows are tested and no reactors found, this would indicate a low infection in the state. He said the state has no swine brucellosis program. The cattle brucellosis program and surveillance for pseudorabies in swine are more urgent than swine brucellosis, he said. He and Frye agreed to consult regarding the present level of testing in the state and the classification for which the state might qualify. The chairman pointed out that in a similar situation last year in Indiana, the result is that Indiana is now a Validated Brucellosis-Free Area.

Tennessee—Dr. Alfred Creswell reported that the situation is similar to that of Missouri. The last reactor was discovered in 1968. About 10 percent of the sows and boars in the state are being tested prior to movement and for herd validation. An MST Program is under discussion in negotiations between state and federal officials.

Texas—Dr. John Holcombe, State Veterinarian, replied by mail because of a conflict with the full Brucellosis Committee meeting. He indicated there have been no changes in the Texas program since December 1981.
The state does quarantine herds in which a reactor is found until the herd has met the test requirements for release of quarantine.

No reports were received from Mississippi, New Mexico, Oregon or West Virginia.

Dr. John Cobb, Georgia State Veterinarian, discussed two proposals. The first was relative to a field trial of an identification device consisting of a 1½-inch circular vinyl backtag, coded with the state prefix, three letters and a three-digit number and applied with a special glue. He listed six advantages for the backtag and indicated that the device is being tried in Georgia.

Cobb presented a proposed change in the swine brucellosis indemnity which he believes will make the program more effective.

Cobb moved, seconded by Lang and carried by the Subcommittee, that the Subcommittee recommend that consideration be given to changing the indemnity schedule as recommended by Cobb (see Addendum 1 to these minutes).

Dr. Phillip Pickerill, Area Veterinarian in Charge in Iowa, reported on studies of boar identification in that state. His data indicated 27.8 percent of boars over 300 pounds at slaughter were successfully identified in Iowa, in spite of problems resulting from lack of enthusiasm for identification. Of 700,000 animals tested in Iowa, there were 145 card positives, of which 21 were rivanol positives. All but 2 of those 21 were successfully traced to farm of origin. Pickerill said the concentration on rivanol positives resulted in a greater change of finding an infected herd and people didn’t feel they were wasting their time. No infected herds were disclosed from the 21 positives, however.

There was discussion of the need for relaxation of testing requirements in validated states, such as movement testing and validated herd testing, and it was agreed that the standards for revalidation will be rewritten when the change to boar only testing is implemented in validated states, which will begin the process of relaxation of testing in validated states.

**SWINE BRUCELLOSIS INDEMNITY PROGRAM**

Proposed by Dr. John Cobb, Atlanta, Georgia

The present swine brucellosis indemnity program is not satisfactory, and the present level of indemnity for the swine brucellosis program is not adequate to entice herd owners to depopulate their herds. There are two reasons it is not working:

1. The rate of indemnity is too low, and
2. The length of time allowed for removal of reactors and exposed breeding animals is too short.

My personal thinking on a workable program is that we need indemnity paid on a graduated amount, depending on the length of time it takes for an owner to dispose of his entire herd. The following guidelines are proposed:
(1) Reactors and exposed breeding swine removed for slaughter within 1–30 days from disclosure of reactors would be eligible for $60 indemnity above salvage.

(2) Reactors and exposed breeding swine removed for slaughter within 31–60 days of disclosure of reactors would be eligible for $50 indemnity above salvage.

(3) Reactors and exposed breeding swine removed for slaughter 61–90 days of disclosure of reactors would be eligible for $30 indemnity above salvage.

The indemnity schedule of payments would be in accordance with the time of disposal of animals, however, the entire herd of breeding animals would have to be sold for slaughter within the 90-day period from disclosure of reactors, and all slaughter type animals sold within six months from disclosure of reactors with no indemnity paid until entire herd is depopulated.

If this graduated indemnity payment is not feasible, then I would recommend a flat $50 indemnity on all reactors and exposed breeding swine and a flat 90-day period to dispose of all breeding animals and six months to dispose of all slaughter type animals.

**SUBJECT:** Suggested Swine Brucellosis Indemnity Programs that would make the Swine Brucellosis Program more effective and workable.

The present swine brucellosis indemnity program is not satisfactory, and is not working in getting swine herds that are brucellosis infected depopulated. There are two reasons it is not working:

(1) The rate of indemnity is too low and

(2) The length of time allowed for removal of reactors and exposed breeding animals is too short.

My personal thinking on a workable program is that we need indemnity paid on a graduated amount depending on the length of time that it takes for an owner to dispose of his entire herd. Maybe something along the following guidelines:

(1) Reactors and exposed breeding swine removed for slaughter within 1–30 days from disclosure of reactors would be eligible for $60.00 indemnity above salvage.

(2) Reactors and exposed breeding swine removed for slaughter within 31–60 days of disclosure of reactors would be eligible for $50.00 above salvage.

(3) Reactors and exposed breeding swine removed for slaughter 61–90 days of disclosure of reactors would be eligible for $30.00 indemnity above salvage.

This indemnity schedule of payments would be in accordance with the time of disposal of animals, however, the entire herd of breeding animals would have to be sold for slaughter within the 90 day period from disclosure of reactors, and all slaughter type animals sold within 6 months
from disclosure of reactors with no indemnity paid until entire herd is depopulated.

If this graduated indemnity payment is not feasible, then I would recommend a flat $50.00 indemnity on all reactors and exposed breeding swine and a flat 90 day period to dispose of all breeding animals and 6 months to dispose of all slaughter type animals.

Georgia Swine Herds—October 1, 1983

1. Quarantined for brucellosis—30
2. Infection detected by testing at sales—15
3. Infection detected by backtags—4
4. Practicing veterinarians testing for diagnosis—14 herds
5. Contact testing and tracing—5 herds
6. Testing for sale—2 herds (Change of ownership)
7. Depopulation in last 12 months—7
8. Released with 2 negative test 120 days or more apart—2

*UM&R Chapter 1, Part II. Procedures—Minimum Standards

I. Classification

4. Rivanol Test

The rivanol test is an official test when conducted in State-Federal laboratories. Complete agglutination at dilutions of 1:25 or more is a reactor in non-vaccinated and vaccinated cattle when the complement-fixation test is not conducted. Less than complete agglutination at the 1:25 dilution is negative.

Agglutination at less than incomplete in the 1:100 dilution is suspect in vaccinated cattle when that interpretation is supported by a complement-fixation test result of suspect using the presently accepted complement-fixation test classification scheme for vaccinated cattle.

Incomplete or complete agglutination in the 1:100 dilution or in higher dilutions is a reactor in non-vaccinated and vaccinated cattle.

With 5 months postvaccination of adult cattle, a less than complete agglutination at the 1:50 dilution is negative.

*Change must also be made in: Part I. Definitions
A. Reactor and
B. Suspect

REPORT OF BRUCELLOSIS INFORMATION
AND EDUCATION SUBCOMMITTEE

Chairman: Dr. Clint N. Jewett
Members present: Dr. W. F. Alexander
Dr. Joseph Bitter
Mr. John S. Cargile
Mr. Tom Cook
Mr. Jim Horne
Meeting opened by Dr. Jewett with seven members and five others present.

REPORTS

The subcommittee heard these reports.

1. Jim Horne told of plans by the Kerr Foundation to inform hard-to-reach producers about brucellosis regions of Four States including:
   - SE Oklahoma
   - NW Louisiana
   - SW Arkansas, and
   - NE Texas

   The Foundation will tell the same story but specially packaged to reach the target audience through—
   - Cattle lenders
   - Sale barn operators
   - Youth groups (Vo Ag, FFA, 4-H)
   - Producer groups

   The Foundation will make use of such things as a—
   - Mobile van or trailer
   - Newsletter
   - Computer

2. Sid Moore reported on APHIS information projects including—
   - Readability study of the UM&R
   - Shipping guide
   - Special print media and radio efforts in Arkansas and Louisiana
   - Emphasis on compliance in current information

   He noted support by Farm Journal’s “Brucellosis Watch” and LCI’s “Brucellosis Progress Report.”


   The Task Force will seek to—
   - Improve the flow of scientific and technical information.
   - Obtain new monies to expand brucellosis research.

RECOMMENDATIONS

The subcommittee recommends that the USAHA—

1. Support and endorse efforts by independent groups such as the Kerr Foundation.

2. Support and endorse efforts to improve both the readability and timely delivery of UM&R provisions.
3. Support and endorse the idea of installing an 800 telephone number to advise accredited veterinarians and others on shipping rules or to refer them to the proper source for such information.

4. Support and endorse the idea of greater community involvement by VMOs and other regulatory officials.

5. Support and endorse the ideas of a stronger active role by Extension Service in brucellosis problem regions.

**UM&R Chapter I, Part II. Procedures—Minimum Program Standards**

1. Classification

3. Complement-Fixation test (CF)—

(No of old language deleted but numbering of subparagraphs had to be changed)

a. The complement fixation test when conducted by *manual* methods approved by National Veterinary Services Laboratories (NVSL) is an official test.

1. Interpretation for all nonvaccinated test-eligible cattle:
   (a). Fifty percent fixation (2 plus) in a dilution of 1:20 or higher—reactor.
   (b). Fifty percent fixation (2 plus) in a dilution of 1:10 but less than 50 percent fixation (2 plus) in a dilution of 1:20—suspect.
   (c). Less than 50 percent fixation (2 plus) in a dilution of 1:10—negative.

2. Interpretation for all test-eligible vaccinated cattle including adult vaccinated animals beginning 2 months post vaccination:
   (a). Twenty-five percent fixation (1 plus) in a dilution of 1:40 or higher—reactor.
   (b). Fifty percent fixation (2 plus) in a dilution of 1:10 but less than 25 percent fixation (1 plus) in a dilution of 1:40—suspect.
   (c). Less than 50 percent fixation (2 plus) in a dilution of 1:10—negative.

b. The complement fixation test performed on the Technicon Automated Complement Fixation Testing System is an official test when conducted by recognized methods.

1. Interpretation for all non-vaccinated test-eligible cattle:
   (a). fixation in a dilution of 1:10 or higher may be classified as reactor.
   (b). fixation in a dilution of 1:5 but no fixation in a dilution of 1:10 may be classified as suspect.
   (c). no fixation in a dilution of 1:5 or lower is negative

2. Interpretation for all test eligible vaccinated cattle including adult vaccinated animals beginning 2 months post vaccination.
   (a). fixation in a dilution of 1:20 or higher may be classified as reactor.
   (b). fixation in a dilution of 1:10 but no fixation in a dilution of 1:20 may
be classified as suspect.
(c). fixation in a dilution of 1:5 or less but no fixation in a dilution of 1:10 may be classified as negative.
COMPARISON OF THE EFFECTS OF CELL CULTURE PROPAGATED BORDER DISEASE VIRUS (BDV) AND BOVINE VIRAL DIARRHEA VIRUS (BVDV) ON THE OVINE FETUS

A. W. McClurkin, DVM, PhD; R. C. Cutlip, DVM, PhD; M. F. Coria, PhD; S. R. Bolin, DVM, PhD

SUMMARY

Cytopathic border disease virus (BDV) adapted to a bovine turbinate cell line produced brain lesions in lambs identical to those produced by two bovine viral diarrhea virus (BVDV) isolates propagated on the same cell line. However, BDV infections of the lambs and their dams could be differentiated from BVDV infections by reciprocal virus neutralization with convalescent serum. Adaptation of BDV to a bovine turbinate cell line appeared to produce greater attenuation than for BVDV, as measured by the number of normal lambs born to BDV-infected ewes.

INTRODUCTION

In early studies, based on clinical signs and lesions, differentiation of border disease virus (BDV) infections and bovine viral diarrhea virus (BVDV) infections in sheep and cattle fetuses was difficult. Acland et al. in 1972 first suggested that BD of sheep might be caused by BVDV. The effect of BVDV on pregnant sheep has been studied experimentally. The only reported effect of one isolate of BVDV on the ewes was one animal with an elevated temperature on days 5 and 6 post-inoculation. Fetal response to inoculation of ewes from the 12th to the 105th day of gestation varied from full-term normal lambs to a few mummified fetuses.

We compared the effects of a cytopathic isolate of BDV and 2 BVDV isolates on ovine fetuses and studied the BDV- and BVDV-neutralizing capacities of sera collected from exposed ewes, and their lambs prior to ingestions of colostrum.

MATERIALS AND METHODS

Source of viruses inoculated into sheep—The border disease virus was isolated from affected lambs and adapted to replicate in bovine turbinate (BT) cells. The cytopathic effect (CPE) of this isolate developed after 7 days and was characterized by sudden rounding of the infected cells and destruction of the cell sheets. Virus concentration was measured by titration on BT cell monolayers grown in culture tubes maintained on a roller drum. The inoculated tubes were held at 35°C for 5 to 7 days.

BVDV isolate 1 came from a persistently infected steer that was raised on a farm with both beef cattle and sheep. The virus was non-cytopathogenic on initial isolation and through the first 5 passages on BT cells, but after the 6th passage, it would occasionally develop CPE similar to that of BDV after 7 to 14 days of incubation. Because of this incon-
sistency, the concentration of isolate 1 was measured by virus interference testing. Briefly, monolayers of BT cells that had been exposed to various dilutions of BVDV isolate 5 days previously were inoculated with 1,000 median cell culture doses (CCID$_{50}$) of a cytopathic isolate of BVDV (Singer). Lack of CPE was interpreted as an indication of the presence of BVDV.

BVDV isolate 2 came from an Idaho steer with an acute case of mucosal disease. The initial isolate was noncytopathic, but after 10 passages, CPE similar to that of BDV developed in some passages and vacuolation of the infected cells similar to that in BVDV developed in other passages. The viruses were titrated in stationary culture tubes, and the end point was determined by observing CPE or interference and the CCID$_{50}$ was calculated by the method of Reed and Muench.

**Virus isolation and virus neutralization**—For virus isolation from live-born lambs, washed precolostraluffy-coat preparations were frozen and thawed, then inoculated into cultures of BT cells. Four-hour cultures were used for isolation of BDV, and 16- to 10-hour cultures for BVDV. For isolation from stillborn lambs, BT cell cultures were inoculated with a 20% emulsion of spleen. The cultures were passaged 3 times at weekly intervals, and the presence of a noncytopathic interfering virus was determined by challenge-inoculating each culture with 1,000 CCID$_{50}$ of a cytopathic BDV virus.

Virus neutralization for BVDV was carried out according to the microtiter method with 100 to 300 CCID$_{50}$ cytopathic BVDV. However, BDV was not adapted to the microtiter method, and to get consistent end points, it was necessary to do the virus titrations and the virus neutralizations in culture tubes. The virus neutralization for BDV was done mixing a 100 to 300 CCID$_{50}$ of a cytopathic BDV virus and twofold dilutions of serum. The tests were read after 5 days of incubation at 35°C and 2 days at room temperature.

**Experimental animals**—All animals were seronegative to BDV and BVDV. Twenty-seven Columbian sheep, 3 to 5 years of age, and 5 ram-bouillet X merino, 3 years of age, were used in these experiments. They were individually bred and grouped so that each virus was inoculated into ewes in a similar range of gestation. None of the ewes had returned to heat within the time they were put on experiment. Nine ewes were inoculated intramuscularly with $5 \times 10^6$ CCID$_{50}$ of the 20th passage of BDV at 58 to 72 days of gestation. Five $\times 10^5$ CCID$_{50}$ of the 9th passage of BVDV isolate 1 were inoculated intramuscularly into 14 ewes at 49 to 72 days of gestation. Five $\times 10^6$ CCID$_{50}$ of the 20th passage of BVDV isolate 2 were inoculated intramuscularly into 9 ewes at 56 to 67 days of gestation. Those ewes that did not deliver lambs were considered to have aborted the conceptus sometime after virus inoculation. Pregnancy continued until interrupted by abortion or birth. Serum and buffy coat samples were obtained from each live lamb at birth, before the lamb had suckled. The precolostral serum was tested for the presence of neutralizing antibodies to BDV and BVDV.
The physical condition of each lamb was evaluated at birth and during the first week of life. Lambs were classified as healthy (those that were nursing and vigorous) or weak (those that were weak or lethargic and needed help to nurse). Four months after virus inoculation, the ewes were bled and serum neutralizing antibody levels for BDV and BVDV were determined by reciprocal virus neutralization tests in BT cells, using culture tubes for the BDV and microtiter plates for BVDV.

Preparation of tissue for histopathology—The weak lambs were killed at various times postpartum; then they and the full-term stillborn lambs were necropsied. Lung, liver, kidney, and brain tissues were fixed in buffered 10% formalin and sections from those tissues were stained with hematoxylin and eosin. In addition, sections from selected tissues were stained with luxol fast blue.

RESULTS

Of 14 lambs born to 9 ewes infected with BDV, 10 were healthy and 4 were weak. Microscopic brain lesions were found in 2 of the weak lambs (Table 1).

Nine lambs were born to 14 ewes infected with BVDV isolate 1: 4 were healthy, 4 were weak, and 1 was stillborn. Five ewes delivered no lambs and may have aborted, and 5 aborted. Three of the weak lambs and the stillborn lamb had brain lesions (Table 2).

Twelve lambs were born to 8 of the ewes infected with BVDV isolate 2. Five were healthy, 1 was strong but had mild muscle spasms, 4 were weak, and 2 were stillborn. One ewe had an apparent abortion. Three of the weak lambs and both stillborn lambs had microscopic brain lesions. No lesions were found in the lamb with muscle spasms when it was killed and necropsied at 6 days of age (Table 3). None of the lambs had abnormal or hairy fleeces.

Virus was not isolated from the precolostral buffy coats or the spleens of the lambs whose dams were injected with BDV. Virus was isolated from the precolostral buffy coats of 2 healthy (20 and 22) and 1 weak (21) lambs (Table 2) infected with BVDV isolate 1. Virus was also isolated from the spleens of 2 stillborn lambs (29 and 30) infected with BVDV isolate 2 (Table 3).

In general, the ewes and lambs that were infected with BDV had the highest titers against BDV, and the ewes and lambs infected with BVDV had the highest titers against BVDV (Tables 1, 2, and 3).

PATHOLOGY

The brain was the only tissue showing lesions. The lesions observed were porencephaly, hydroencephaly, and cerebellar cortical dysphasia and were similar regardless of the type of virus. Multiple fluid-filled cavities of variable size were present in the white matter of the cerebral hemispheres. The fusiform white matter of the posterior pole of the cerebral hemispheres was frequently affected. The least severe changes were focal de-
myelination and malacia. The ependyma near the malacic foci was disrupted, and the ependymal cells formed acinar structures. The smallest cavities were areas of liquefaction surrounded by necrotic parenchyma. Large cavities were surrounded by macrophages and multiple nodules of astrocytes. Many macrophages contained a yellow brown pigment. Neurons were not affected.

Several large cavities contained irregular clusters of free-floating neurons. Cavitation of the cerebellum was limited to small holes in areas of malacia at the tips of the focal white matter. Dysphasia of the cerebellar cortex was manifest as single or multiple areas of disarray and loss of cortical order. The layers of cortex were irregularly arranged and the granular cell layer was often thin or missing. This disorder involved the entire cerebellar cortex of 1 lamb. An arteritis with necrosis of the media and accumulation of mononuclear cells in the adventitia was seen in the thalamus of 1 lamb. The brain lesions described here are identical to those described by Barlow and Zakarian et al for ovine fetuses infected with either BDV or BVDV.

**DISCUSSION**

Infection of ewes during gestation with cell-adapted BDV resulted in fewer abnormal lambs than infection of pregnant ewes with either of the two BVDV isolates. However, adaptation of BDV to a bovine cell line may have caused greater attenuation for BDV than for BVDV.

Initially, the BDV isolate used in these studies produced complete lysis of the cell sheet within 10 days of inoculation on 16- to 10-hour cultures of BT cells with incubation carried out at 35 C. However, with passage the development of CPE was not consistent and, when CPE did develop, the incubation period varied from 4 to 10 days. With continued experimentation, we found that the virus was quite sensitive to the temperature of incubation and the age of the cell at the time of inoculation.

Although the process of adaptation of BDV to BT cells may not have been complete at the time these experiments were undertaken, consistent reproducible virus titers and virus neutralization titers of convalescent and immune sera were obtained.

There was variation in titer between individual animal sera in response to either BDV or BVDV as recorded in Tables 1–3. However, the titers show a strong cross reaction between BDV and BVDV in several convalescent and precolostral lamb sera, indicating that BDV and BVDV share a common antigen. Nevertheless, there was a significant difference in titer in most sera when the homologous virus was used and compared the titer of the heterologous virus. We believe differentiation between BDV and BVDV infection in sheep and cattle can be accomplished by reciprocal neutralization using several convalescent serum samples, perhaps at least 5%, from the flock or herd.

The similarity in the disease produced by either BDV or BVDV in ovine fetuses is emphasized both by the nature of the clinical response, as well as
the lesions produced in the brain by the two viruses.

REFERENCES

17. Barlow, R. M.: Morphogenesis of hydranencephaly and other intracranial
186 McClurkin, Cutlip, Coria, Bolin


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<th>Ewe</th>
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a Reciprocal of serum dilution capable of neutralizing 100 to 300 TCID<sub>50</sub> of cytopathic BDV.

b Reciprocal of serum dilution capable of neutralizing 100 to 300 TCID<sub>50</sub> of Singer isolate of BVDV.

c Weak lambs were killed and necropsied after birth on the days indicated in parentheses. ND = Not done.
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aReciprocal of serum dilution capable of neutralizing 100 to 300 TCID$_{50}$ of cytopathic BDV.

bReciprocal of serum dilution capable of neutralizing 100 to 300 TCID$_{50}$ of Singer isolate of BVDV.

cWeak lambs were killed and necropsied after birth at the times indicated in parentheses.

ND = not done, PI = postinfection.
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<sup>b</sup> Reciprocal of serum dilution capable of neutralizing 100 to 300 TCID<sub>50</sub> of Singer isolate of BVDV.

<sup>c</sup> Number in parenthesis represents the day lamb was killed

ND = Not done
INFECTIOUS DISEASES OF CATTLE COMMITTEE

Chairman: Vaughn A. Seaton, Ames, IA

W. F. Alexander, OK; A. A. Anderson, MD; R. P. Azelton, MO; H. T. Barron, TN; D. E. Bartlett, WI; Joe Bearden, MS; L. N. Brown, WA; E. A. Carbrey, IA; C. S. Card, PA; Pablo Correa Giron, Mexico, DF; R. P. Crawford, TX; G. L. Crenshaw, CA; J. F. Evermann, WA; R. W. Fulton, OK; G. D. Gurss, KS; R. F. Hall, GA; W. T. Harrer, MT; R. E. Horton, NJ; N. W. Kruse, NE; G. Lambert, IA; A. J. Luedke, CO; M. L. Main, SD; C. S. McCain, OK; A. W. McClurkin, IA; C. A. Mebus, NY; Joyce Mitteness, MN; M. A. Mixson, AL; B. F. Newcomb, MT; P. A. O'Berry, IA; B. I. Osburn, CA; J. O. Pearce, JR., FL; S. L. Reynolds, TX; J. A. Schmitz, OR; R. D. Schultz, WI; L. M. Siegfried, WI; W. L. Sippel, FL; Richard Smith, KS; P. L. Spencer, IL; Dan Suther, CA; N. R. Swanson, WY; M. Van der Maaten, IA

The committee met at 1:30 p.m., October 20, 1983. Sixteen members were present in the approximately 35 in attendance.

Brief presentations were made on five topics including: 1) Vesicular Stomatitis in cattle—an update by Dr. Lonnie King, Veterinary Services, APHIS, Hyattsville; 2) Bovine Respiratory Syncytial Virus—by Dr. Merwin Frey, Department of Veterinary Science, University of Nebraska, Lincoln, Nebraska; 3) Viral Contamination of Semen—Dr. Ronald Schultz, Department of Pathobiological Science, School of Veterinary Medicine, University of Wisconsin, Madison, Wisconsin; 4) Infectious Bovine Keratoconjunctivitis: A Review by Dr. George W. Pugh, Jr., National Animal Disease Center, Ames, Iowa; and 5) Comparison of Border Disease Virus and Bovine Viral Diarrhea Virus by Cell Culture.

VESICULAR STOMATITIS

It was pointed out that the enigma of V.S. still exists in many ways after thirty different outbreaks over decades of time. Studies still leave the question of mode of transmission, reservoirs, maintainence mechanism and its true pathogenesis.

The disease always occurs sporadically with the most recent epizootic beginning in Arizona in May, 1982. Subsequently, horses and cattle were infected in 14 states over the next year and the New Jersey strain was consistently isolated as the causative agent. Six hundred sixteen premises were declared VS-N.J. strain positive based on virus isolations or clinical signs with concurrent significant seroconversion titers.

Interesting data occurred such as: 1) the disease persisted during the winter; 2) V.S. definitely spread with the movement of livestock; 3) good evidence exists that only the “tip of the iceberg” was discernible insofar as infected herds are concerned; 4) serum collected from wildlife ungulates suggest the concept that many animals were exposed to the virus; 5) V.S.-N.J. was isolated from a variety of insects and small animals in the epizootic region; 6) Feral hogs in Southeastern United States have shown a
high percentage of seroconversion to V.S.-New Jersey; 7) Movement of infected cattle that have previously experienced clinical manifestation of V.S. were important in the subsequent transmission of the disease.

The epizootic in domestic livestock ceased about as quickly as it had initially appeared. It was last diagnosed in March, 1983.

BOVINE RESPIRATORY SYNCYTIAL VIRUS IN CATTLE

This infection has been found to be associated with two disease conditions: a) A mild respiratory disease from which virus can be isolated with little titer rise and b) an acute respiratory distress syndrome from which it is hard to isolate the virus but which affects a dramatic titer rise.

The mild condition can be of significance if secondary bacterial respiratory infection occurs and requires prompt antibiotic treatment. The acute condition has not been reproduced experimentally and is thought to be the result of the syncytial virus interacting with other factors such as weather, nutritional state and genetic makeup.

One factor which seems to be significant in either form is pulmonary edema.

Vaccination appears to be a possible way to prevent the acute disease, but even then, the virus continue to cause infection of ciliated respiratory epithelium and predisposes to bacterial infection. Extensive serological surveys in several states indicate 50–70% positive animals. This investigation knew of no negative herds.

VIRAL CONTAMINATION OF SEMEN

Viral contamination of semen and of the embryo is of concern to the cattle industry especially to the artificial insemination industry.

The viruses studies were IBR, BVD, Bluetongue, bovine leucosis virus and bovine papilloma virus.

In-vitro and in-vivo tests have been utilized to study virus occurrence in semen including over 200,000 ejaculates over 10 years time. Methods for testing the semen were described. Bulls studied in an artificial insemination study showed that 100% serologically positive for IBR due to repeated vaccinations have never in ten years had an IBR virus isolation from the semen. Bulls which were 11% positive to bovine leucosis virus serologically have no leucosis virus isolations from semen. There was no bovine herpes mamillitis virus isolation from bulls which were 7% serologically positive. There were no bull serologically positive for blue tongue but a virus was isolated from one bull. Bulls which were 50% positive serologically to BVD yielded BVD virus in the semen of about 20–25% incidence. A method to reduce or eliminate viral contamination called "immunoextender" was discussed. It is believed this method of controlling viruses in semen will be similar to antibiotic control of bacterial contamination in semen.
INFECTIOUS BOVINE KERATOCONJUNCTIVITIS: A REVIEW

Research on infectious bovine keratoconjunctivitis (IBK) over the past twenty years has led to a better understanding of the pathogenesis and immunogenesis of this disease. Investigators have elucidated the etiology which includes many factors (stresses, microbes, and traumas) that influence the induction of lesions by *Moraxella bovis*, the primary causative agent. This has led to important studies on the immunogenicity and pathogenicity of *M. bovis* infection and some of these studies indicate that a vaccine against IBK is feasible. The use of knowledge on immunogenicity in conjunction with that on adjuvants, immunologic procedures, and methods in genetic engineering should facilitate the development of a suitable vaccine for the control of IBK within the next several years.

Additional research in the following areas would be beneficial:

1. Interaction of biological (microbes, hormonal and physiological imbalances, and genetics) and physical (climatic, management, nutritional, and shipping) stresses on the development of IBK.
2. Research on specific immune mechanisms associated with mucosal surfaces (conjunctivae) where physio-anatomical barriers might neutralize some of the effects of systemic immunoglobulins.
3. Research directed toward the production of large quantities of immunogenic cultures or fractions of *M. bovis* for vaccines.
4. Development of improved immunization methods to shorten the time (28 to 48 days at present) it takes an animal to develop immunity.

COMPARISON OF EFFECTS OF CELL CULTURE PROPAGATION OF BORDER DISEASE VIRUS AND BVD IN THE BOVINE FETUS

The antigenic relationship between BDV and BVDV prompted a study comparing the affect of the 2 viruses on the fetuses of sheep and on the lamb that developed from those infected fetuses.

One isolate of BDV and 2 isolates of BVDV propagated on bovine turbinate cells were injected into pregnant ewes 49 to 72 days of gestation. Normal lambs and diseased lambs were born to the 3 groups of ewes. Histopathology of the weak and still-born lambs revealed identical lesions in the brain for either BDV or BVDV.

However, reciprocal virus neutralization by convalescent serum of the ewes and lambs indicated the viral infections could be differentiated by the neutralization titers of the serum against BDV and BVDV.
LEPTOSPIRA TARASSOVI IN ALABAMA CATTLE: SEROLOGIC EVIDENCE

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Charles S. Roberts Veterinary Diagnostic Laboratory
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SUMMARY

Antibodies to *Leptospira tarassovi* were detected in cattle serum samples throughout Alabama with a major concentration in counties along the Alabama River and its tributaries. A 700 cow beef herd with a low reproductive rate in replacement heifers was evaluated to determine if *L. tarassovi* was causing the problem. Serologic testing and an *L. tarassovi* bacterin were evaluated in relation to pregnancy to resolve the question. The *L. tarassovi* serologic data, vaccination and pregnancy data obtained from the replacement heifers in this study revealed that there was no significant association between pregnancy, vaccination, or reactivity to *L. tarassovi*. It was concluded that *L. tarassovi* did not cause the reproductive problem in the replacement heifers.

INTRODUCTION

The purpose of this paper is to report the occurrence of serum antibodies to *Leptospira interrogans* serovar *tarassovi* in Alabama cattle and its relationship to reproductive failure in a herd study. The case study involved a commercial beef herd that had approximately 40% reproductive failure in replacement heifers each year over a 3 year period.

MATERIALS AND METHODS

Serum samples from cattle sent to the Veterinary Diagnostic Laboratory for various serologic tests in 1981 through the middle of 1983 were included in the *L. tarassovi* survey. Wild animal serum samples collected for other disease studies during the 1980 to 1983 trapping seasons in Lee and Macon counties were tested for inclusion in this survey.

An improved microscopic agglutination test described by Cole et al (1973) was used to evaluate the serum samples for antibodies to 6 leptospiral serovars (*L. canicola, L. grippotyphosa, L. hardjo, L. icterohemorrhagiae, L. pomona, L. tarassovi*). A 50% agglutination of leptospira antigen in a 1:100 serum dilution was considered reactive. Specificity of agglutinating antibodies of 20 *L. tarassovi* positive serum samples was evaluated by immunoadsorption studies using homologous antigen. Leptospiral cultures were made in bovine albumin polysorbate (BAP) medium with 2% rabbit serum. Urine samples were collected from cattle using Lasix a to stimulate urination. Serial tenfold dilutions of urine (4 dilutions and 2 replicates) in BAP medium were made immediately after collection of the urine and the diluted urine was incubated at 29°C. Kidneys were

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aTaylor Pharmacal Co., Decatur, IL 62525
collected at slaughter, transported immediately to the laboratory, tissue samples from 6 sites of each kidney were ground, and serial tenfold dilutions (4 dilutions and 2 replicates) of each sample site cultured at 29°C in BAP medium.

An *L. tarassovi* bacterin was prepared by culturing the organism in BAP medium at 29°C for 5 days, harvested by centrifugation, washed in phosphate buffered saline 3 times, and the cell density standardized at an OD of 0.06 at a wavelength of 540 nm by spectrophotometry. The *L. tarassovi* bacterin was heat inactivated at 56°C for 1 hour. One ml of the *L. tarassovi* bacterin was injected intramuscularly (IM) into each of the 103 1983 replacement heifers the first of December 1982. A second injection (1 ml) of the vaccine was administered IM one month later.

Multiple techniques were used to determine if *L. tarassovi* was involved in the reproductive problem of the replacement heifers. Serum samples were collected from 1982 replacement heifers at the time of pregnancy testing and tested for antibodies to *L. tarassovi* for comparison with pregnancy. Another technique was to collect serum samples for comparison from all 1983 replacement heifers in September 1982 and at pregnancy testing. Serum samples were collected from 20 *L. tarassovi* vaccinated and 20 nonvaccinated replacement heifers in December 1982, January, and April 1983 for comparison. Half of the replacement heifers were vaccinated with an *L. tarassovi* bacterin prior to the breeding season and were compared. An extensive evaluation was made of the herd management, nutrition and disease status to rule out other probable causes of the low reproductive rate. Interactions among the pregnancy, serologic reactivity and vaccination status were analysed using statistical programs for Social Sciences.

**RESULTS**

Serologic results from *L. tarassovi* tests of 11,474 cattle serum samples collected from 2551 herds during a 2 year survey with all Alabama counties represented are presented in Figure 1 as percentage of reactive serum samples by county. The counties with 7% or greater reactive serum samples are emphasized with vertical lines and follow the Alabama River from Perry County south to the Gulf of Mexico. Macon County to the east also had a high percentage (17%) of reactive serum samples. The 20 *L. tarassovi* reactive serum samples treated by immunoadsorption were negative on retest.

The 235 wild animal serum samples collected in Lee (105 samples) and Macon (130 samples) counties were negative for *L. tarassovi* antibodies. They consisted of 101 opossums, 68 raccoons, 34 foxes, 10 muskrats, 8 cotton rats, 3 bobcats, 3 feral cats, 2 coyotes, 2 otters, 2 feral dogs, 1 mink, and 1 deer.

Fifty-three percent of the 198 serum samples from the 1982 replacement heifers had antibodies to *L. tarassovi* at the August 1982 bleeding, with the titers ranging from 1:100 to 1:800. All 198 serum samples were negative
for *L. canicola*, *L. grippotyphosa*, and *L. pomona* antibodies with only one reactive to *L. hardjo* at 1:100 and 5 for *L. icterohemorrhagiae* at 1:100 or 1:200.

None of the 1983 replacement heifers had antibodies to *L. tarassovi* or the other 5 leptospira serovars in the September or December 1982, or January 1983 serum samples. The *L. tarassovi* results of 2 later serum samples from some of these heifers are shown in Table 1. Thirteen *L. tarassovi* vaccinated heifers and 12 unvaccinates are represented. Four of the 13 vaccinated heifers and 5 of the 12 unvaccinated heifers were open at the July 1983 pregnancy evaluation.

One hundred and seventy-three 1983 replacement heifers were remaining at the July 1983 pregnancy evaluation. Forty-four of 74 (59%) *L. tarassovi* vaccinated heifers and 58 of 99 (59%) unvaccinated heifers were pregnant.

Attempts were made to isolate *L. tarassovi* from kidneys of 4 open 1981 replacement heifers, and kidneys of 6 open 1982 replacement heifers which had *L. tarassovi* antibody titers ranging from 1:100 to 1:800 without success. Urine samples collected every second or third day during a 2 week period from 4 open 1982 and 6 open 1983 replacement heifers with *L. tarassovi* titers were also cultured without success.

**DISCUSSION**

*Leptospira tarassovi* antibodies have been reported in serum samples from Florida (White et al, 1981; White et al, 1982; White and Sulzer, 1982) and Georgia cattle (Cole et al, 1983). Six hundred and seventeen of 11,474 Alabama cattle serum samples were reactive to *L. tarassovi*. The highest percent of reactive serum samples for *L. tarassovi* were obtained from cattle in counties along the Alabama river or its tributaries.

Since an isolate of *L. tarassovi* has been reported from a turtle (*Pseudemys* sp.) in the United States (Sulzer, 1975), turtles should be considered while searching for a reservoir of the organism. This concept is supported by the observation that all the wild mammalian serum samples evaluated in this study were negative for *L. tarassovi* antibodies. The greatest number of reactive cattle serum samples were closely associated with a major river system and the range of 6 *Pseudemys* species of turtles overlap in Alabama (Conant, 1958).

*Leptospira tarassovi* may be a cause of reproductive disease in swine (Galton, 1966; Sulzer, 1975; Wandurski, 1982). Wandurski (1982) reported that approximately 20% of a 2500 pig herd developed antibodies to *L. tarassovi* and that 70% of the 260 aborting sows reacted to *L. tarassovi* antigen. The abortions in the swine were controlled by streptomycin treatment.

White and colleagues (1981, 1982) did not report clinical disease to be associated with the presence of *L. tarassovi* antibodies in Florida cattle. The pregnancy status and *L. tarassovi* serologic reactivity of the 1982 replacement heifers from the Alabama 700 cow beef herd did not correlate,
however, these comparative evaluations were not considered reliable due to the 5 months between the end of breeding and blood collection. The serologic data obtained from the 5 sets of serum samples collected from the 1983 replacement heifers before, during and after the breeding season did not show any correlation between reproductive failure and reactivity to *L. tarassovi*. The heifers that were given the *L. tarassoui* bacterin had the same percentage of nonpregnant animals as the unvaccinated heifers. The question of efficacy of the bacterin could be raised because the number of reactors in the serum samples from vaccinated and unvaccinated animals (Table 1) was the same. However, a lack of reactivity of this nature is not uncommon for commercially available leptospira vaccines. The reported observations support the contention that *L. tarassoui* was not the cause of the reproductive problem in the replacement heifers of this 700 cow beef herd in Alabama.

**REFERENCES**

Table 1. *Leptospira tarassovi* antibodies in 3 sequential serum samples and fertility of 1983 replacement heifers.

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* All samples also negative in September and December 1982
** The number is the reciprocal of the serum dilution with 50% agglutination.

Neg = Negative, ND = Not determined, Open = Nonpregnant, Preg = Pregnant
Figure 1. Percentage of cattle serologically reactive for *Leptospira tarassovi* by county (1981–1983). Shaded counties had at least 7% of the serum samples reactive.
PREVALENCE OF LEPTOSPIRAL ANTIBODIES IN GEORGIA CATTLE AND SWINE, WITH EMPHASIS ON LEPTOSPIRA INTERROGANS SEROVAR TARASSOVI

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SUMMARY

Serum samples from 13,164 cattle were tested over a 5 year period for antibodies against leptospiral serovars pomona, hardjo, grippotyphosa, icterohaemorrhagiae, canicola, tarassovi, and autumnalis. A total of 1,797 (13.7%) was considered vaccinated, based on the assumption that any animal in the herd positive at a dilution of 1:50 or greater to at least 3 of 5 serovars used in bacterins had been vaccinated. A reactor rate to any of the serovars at a dilution of 1:50 or greater was observed in 52.0% of the cattle. The percentage of positive cows that reacted to serovar hardjo declined from 68.7% to 56.0% during this period. A significant increase to serovar icterohaemorrhagiae, from 4.4% to 21.6% (P<.005), was detected. The greatest change in the positive reactor rate occurred with serovar tarassovi, which increased from 10.4% to 35.2% (P<.0005). Distribution of the tarassovi reactors was statewide, and the greatest increase occurred in 1981 and 1982. Agglutinin-absorption techniques verified the specificity of the tarassovi reaction in a selected group of 6 cows. No isolations of serovar tarassovi were made.

Serum samples from 17,359 swine were tested for leptospiral antibodies to the same serovars as for cattle. A total of 746 (4.3%) was considered vaccinated. A reactor rate of 33.1% was observed in the nonvaccinated animals. There was a general decline in the percentage of serologic reactions in 1982. The greatest increase, i.e., 21.5% to 51.3%, (P<.005) occurred in the number of positive pigs reacting to serovar icterohaemorrhagiae. The percentage of pigs reacting to serovar autumnalis decreased from 64.8% to 34.2% (P<.005).

INTRODUCTION

Leptospirosis is a major disease of cattle and swine that has been reported from most areas of the United States. The serovars commonly associated with infections in cattle are pomona, hardjo, and grippotyphosa. Serovars pomona and grippotyphosa are usually reported to infect swine. There is little evidence that hardjo is a problem in swine.

Serovar tarassovi has been reported as a cause of infection in man, swine, cattle, and feral animals from many countries. Abortions have been found in swine, but no severe clinical manifestations have been

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reported in cattle. This serovar, which has been isolated from turtles, surface water, and wildlife in Georgia, has not been shown to cause clinical disease in cattle and swine in the U.S. The serologic prevalence of leptospirosis in Georgia cattle and swine from 1978 through 1982, with emphasis on serovar tarassovi, is the subject of this report.

MATERIALS AND METHODS

Samples. Serum from cattle and swine were submitted by veterinary practitioners located throughout Georgia. Many of these samples were from animals suspected of having leptospirosis.

Antigen. Five-to-7-day-old cultures of serovars pomona, hardjo, grippotyphosa, icterohaemorrhagiae, canicola, tarassovi, and autumnalis in Ellinghausen, McCullough, Johnson, Harris (EMJH) medium were utilized as previously described.

Test procedure. Serum samples were screened at a 1:50 dilution and the antibody levels of positive samples were determined by the microscopic agglutination (MA) test. Studies utilizing agglutinin-absorption and 2-mercaptoethanol (2-ME) treatment of sera from a selected group of 6 breeding age beef heifers were performed to determine the specificity of the serovar tarassovi reaction and to determine the immunoglobulin class. Urine was also collected from these 6 heifers, diluted 1:10 in 1% bovine serum albumin, transported to the laboratory, and cultured within 1 hour after collection. The isolation medium used was EMJH semisolid containing 2% rabbit serum. Procedures for urine culture have been previously described.

Methods of evaluation. All sera causing agglutination of 50% or more of the leptospires in any one serovar at a dilution of 1:50 or greater were considered positive. Cattle and swine were considered vaccinated if any animal in the herd was positive at a 1:50 dilution or greater on the MA test to at least 3 of 5 serovars used in bacterins (pomona, hardjo, grippotyphosa, icterohaemorrhagiae, and canicola). Results of vaccinated animals were tabulated separately. Animals positive to serovars tarassovi and autumnalis were included in the results even if the animal was considered to be from a vaccinated herd. The chi-square test was used to determine the significance of changes in the prevalence of serologic reactions. The number positive per 100 animals was used.

RESULTS

Bovine. From January, 1978 through December, 1982, sera from 13,164 cattle were tested for leptospiral antibodies. Of these, 1,797 (13.7%) were considered vaccinated. The rise in the percentage of animals considered to be vaccinated each year as shown in Figure 1 indicates increased use of bacterins.

During this 5 year period, sera from 12,875 cattle which were not classified as vaccinated were tested. Of these, 52.0% (6,696) were positive.

*Difco Laboratories, Detroit, MI.
to at least 1 serovar at a dilution of 1:50 or greater.

The percent of cattle which were positive to at least 1 serovar, the percent of positive cattle which were positive to a specific serovar, and the percent of all cattle tested which were positive to a particular serovar is shown in Figure 2.

There was no significant change in the percentage of animals reacting to serovars *pomona*, *grippotyphosa*, *canicola*, and *autumnalis* during this 5 year period. The percent of serologic positive cows which reacted to serovar *hardjo* declined from 68.7% (1,037 of 1,509) to 56.0% (789 of 1,409) (P<.10). The percent of *hardjo* positive cows with respect to all cows tested also declined, but not at a significant level.

The percent of positive cows that reacted to serovar *icterohaemorrhagiae* increased from 4.4% (66 of 1,509) to 21.6% (305 of 1,409) (P<.005). For all cows tested, the percentage increased from 2.1% (66 of 3,076) to 11.4% (305 of 2,668) (P<.10).

The most dramatic and significant increase occurred in response to serovar *tarassovi*. Of the positive animals, reactors to this serovar increased from 10.4% (157 of 1,509) to 35.2% (496 of 1,409) (P<.0005), and from 5.1% (157 of 3,976) to 18.6% (496 of 2,668) (P<.005) of all cattle tested. The distribution of serovar *tarassovi* reactors by geographic district is shown in Figure 3. The number of animals reacting at dilutions of 1:50 and 1:100 or greater is shown separately. The greatest increase in reactor rate occurred in 1981 and the trend continued through 1982 in all districts, except the northern district where it was relatively consistent throughout the testing period.

Serum and urine samples from the 6 cows in the selected group were collected for serologic testing and leptospira isolation. Results of serologic testing for serovar *tarassovi* are shown in Table 1. These cows were negative in their serologic reactions to *pomona*, *hardjo*, *grippotyphosa*, *icterohaemorrhagiae*, *canicola*, and *autumnalis* antigens. There was no significant increase in titer to serovar *tarassovi* at the time of the second bleeding. Treatment of the sera with 2-ME indicated that IgG was the predominant immunoglobulin detected. Agglutinin-absorption studies to determine specificity showed that the reaction was specific for serovar *tarassovi*. No leptospires were isolated from urine collected from the cows.

*Porcine*. From January, 1978 through December, 1982, sera from 17,359 swine were tested for leptospiral antibodies. Of these, 746 (4.3%) were considered vaccinated. Percentages of vaccinates by year is shown (Fig. 1), and there is no serologic evidence of increased usage of bacterin during this time.

Of the 17,050 swine tested which were not considered vaccinated, 33.1% (5,650) were positive to at least 1 serovar at a dilution of 1:50 or greater. Data is presented for serologic reactions to each serovar on a yearly basis (Fig. 4). The arrangement of the data is the same as for cattle.

Although the number of animals tested increased in 1982, the percent of
positive reactors declined. There was no significant change in the percentage of reactors to serovars *grippotyphosa* and *canicola* during the evaluation period. Although not significant, the percentage of positive pigs reacting to serovar *pomona* was somewhat higher during the last 3 years of testing, but there was no change in the *pomona* reactors as a percentage of all pigs tested.

In 1981 and 1982, a nonsignificant increase was detected in the percent of positive pigs reacting to serovars *hardjo* and *tarassovi*, but this trend was not observed when compared to all pigs tested.

A significant increase, 21.5% (330 of 1,536) to 51.3% (457 of 891) (P<.0005), in the percent of positive pigs reacting to serovar *icterohaemorrhagiae* was observed during the test period, especially during 1981 and 1982. This increase was not significant when compared to all pigs tested.

There was a significant decline, 64.8% (994 of 1,536) to 34.1% (304 of 891) (P<.005) in the number of pigs reacting to serovar *autumnalis* when compared to those pigs positive for any serovar. A significant decline, 24.0% (994 of 4144) to 7.1% (304 of 4251) (P<.01) was also found when the percentage was based on all pigs tested.

**DISCUSSION**

The prevalence of leptospiral antibodies in Georgia cattle during 1957 was 69%.

The 52.0% reactor rate reported in this 5 year study is lower than the rate in 1957, and this decrease would have been even greater if serovars *tarassovi* and *autumnalis* had not been included along with the 1:50 dilutions. Every effort was made to eliminate data from vaccinated animals so that it would not be included when determining the serologic reactor rate.

The decline in the percentage (68.7 to 56.0%) of serologic reactions in cattle to *hardjo* during the 5 year period may be due to the widespread use of commercial bacterins containing this serovar. An increase in the reactor rate to *icterohaemorrhagiae* in both cattle (4.4 to 21.6%) (P<.005) and swine (21.5 to 51.3%) (P<.0005) was observed during this time. However, it should be noted that 69.2% of the *icterohaemorrhagiae* reactors in cattle, and 72.5% in swine, were at a dilution of 1:50.

The significant increase in the number of *tarassovi* reactors in cattle (10.4 to 35.2%) (P<.005), and to a lesser extent in swine (1.1 to 4.8%), can not be fully explained. Serologic evidence indicates that the serovar is present throughout the state, and there was no seasonal change in prevalence during this period of study. No clinical disease has been reported which has been definitively associated with infections caused by *tarassovi*. It has been suggested as a cause of reproductive failure in some herds, but we have been unable to demonstrate proof by either an increase in antibody titer or by culture.

Serovar *tarassovi* was isolated from striped skunks, raccoons, wildcats, and opossums in Georgia during the 1950's and 1960's. More recently
LEPTOSPIRA INTERROGANS SEROVAR TARASSOVI

this serovar was isolated in Georgia from surface water contaminated with raw sewage and from turtles inhabiting these waters. Antibodies to tarassovi were found in the sera of cattle and swine from Oklahoma, and in sera of humans and cattle involved in a leptospirosis outbreak caused by pomona and hardjo in Florida. Based on reports documenting the presence of this serovar by culture, consideration should be given to water sources and the wildlife population as reservoirs of tarassovi. Because 58.7% of the tarassoui reactor cattle statewide reacted at dilutions of 1:100 or greater, tarassovi must be considered a potential problem causing serovar.

REFERENCES

Table 1. Serologic Results and Specificity of Reactions in serovar *tarassovi* - Positive Cattle

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a - Bleeding Date - 1/31/83  
b - Bleeding Date - 2/10/83  
MAT (Microscopic Agglutination Test)  
2-ME (2-Mercaptoethanol)
LEPTOSPIRA INTERROGANS SEROVAR TARASSOVI 205

Figure 1. Percent of Cattle and Swine Vaccinated Against Leptospirosis: 1978-1982
Figure 2. Percent of Cattle Positive for Each of 7 Leptospiral Serovars: 1978-1982
FIG. 3. DISTRIBUTION OF SEROVAR TARASSOVI-POSITIVE CATTLE IN GEORGIA
Figure 4. Percent of Swine Positive for Each of 7 Leptospiral Serovars: 1978-1982
REPORT OF THE 1983 COMMITTEE ON LEPTOSPIROSIS

Chairman: S. L. Diesch, St. Paul, MN
Vice Chairman: H. C. Ellinghausen, Jr., Annapolis, MD

J. J. Cecil, IA; J. R. Cole, Jr., GA; John Finnell, IL; R. F. Hall, GA; L. E. Hanson, IL; Rube Harrington, Jr., IA; C. M. Hibbs, NM; P. B. Kimsey, CA; C. A. Kirkbride, SD; M. L. Main, SD; R. L. Mortor, IN; Robert Nervig, IA; H. L. Rubin, FL; H. B. Songer, AZ; A. B. Thiermann, IA; D. N. Tripathy, IL; F. J. Wedam, OR; F. H. White, FL; J. L. Williams, MO.

A summary of the paper "Prevalence of Leptospiral Antibodies in Georgia Cattle and Swine with Emphasis on Leptospira interrogans serovar tarassovi" was presented by Dr. Cole, GA. Their findings indicated a 5 year reduction in cattle with antibodies against hardjo and an increase in icterohaemorrhagiae and tarassovi reactor rates. In swine, antibodies to serovar icterohaemorrhagiae increased and autumnalis decreased. This paper appears elsewhere in the 1983 Proceedings, together with a paper on Leptospira tarassovi in Alabama Cattle by Dr. Lauerman, et. al.

Dr. Hanson, IL, updated the committee on equine leptospirosis. Leptospirosis has been identified as a disease in horses throughout the United States as well as in many countries of the world. Serologic reports of the prevalence of microscopic agglutination reactor rates of between 7% and 46% have been reported from various horse populations in the United States with an average of approximately 20% of the horses having agglutinins for one or more serovars.

The clinical manifestations of malaise, weak colts, abortion and recurrent uveitis can be costly burdens for the horse owner. The lack of pathognomonic signs associated with the disease has created some confusion concerning the significance of the disease. Recent isolations of leptospires from aborted equine fetuses suggest that leptospiral infections may be significant contributors to equine fetal losses. The Committee reaffirmed that there is no licensed leptospiral vaccine available for use in horses in the United States.

Dr. Hanson, IL, also reported on human leptospirosis among military personnel in Panama. Leptospirosis has been identified as a continuing clinical problem among U. S. Army troops involved in jungle training. The disease has been recognized primarily as an undiagnosed febrile illness with associated severe headaches. During the last two years 5% of combat trainee groups sent to Panama during fall and early winter months contracted clinical leptospirosis. The cases have involved 19 serovars which have been identified serologically and through isolation from blood culture during febrile illness. About 60% of the cases were detected only when using local isolates as antigens for identification rather than with the WHO antigens. Prophylactic medication utilizing a long-lasting tetracycline which produces prolonged blood levels was effective in suppression of clinical illness in a clinical field study in troops. This illustrates the importance of the need for leptospiral typing in epidemiologic studies.
Dr. White, FL, reported that 37 leptospiral isolates were made from 210 kidney cultures of feedlot cattle slaughtered in Florida. Of the isolates, 23 were serotyped as *hardjo*, 5 *balcanica*, 1 *pomona*, and 8 others have not been completely identified. He emphasized the importance of the improvement and standardization of isolation media for the isolation of leptospires from specimens.

Dr. Rubin, FL, indicated that monograph III, Laboratory Diagnosis of Leptospirosis; which describes the "Serological Characterization" is being prepared by Dr. Ellinghausen, MD; Dr. Cole, GA; and Dr. Rubin, FL; will be completed for publication in 1984.

Dr. Thiermann reported to the Committee that the USDA has established a National Reference Center for Leptospirosis in Ames, Iowa. Such a Center will function as two separate sections: a) a Diagnostic Section under APHIS, NVSL, represented by the Chief of the Diagnostic Bacteriology Laboratory, and a b) Research Section under ARS, NADC, represented by the Leader of the Leptospirosis Research Laboratory.

APHIS will be responsible for: a) providing additional serological capabilities; b) developing competency to type leptospiral serovars; c) providing training and reagents; and d) providing epidemiological consultations for the control of leptospirosis in domestic animals.

ARS will be responsible for: a) developing improved techniques for the isolation and characterization of leptospiral serovars; b) expanding research efforts to determine the pathogenicity of unrecognized leptospires; c) identifying and characterizing immunogenic components of leptospiral serovars; and d) developing and improving diagnostic techniques.

APHIS is currently looking for personnel to staff their section of the Center. Official announcements will be made when the submission of samples or requests for reagents can be initiated through the Center.

Dr. Thiermann also reported on recent developments in the areas of improved isolation procedures and isolation media. Cattle and swine isolates are often being detected after 2-weeks of incubation. Pathogenicity studies are being continued in cattle. A newly developed ELISA test for the detection of leptospiral antibodies in cattle is being adapted for field use. Recently, a cooperative project has been initiated between NADC and the University of North Carolina to conduct basic molecular biology studies on serovar *hardjo*.

Serological evidence of serovar *bratislava* has been demonstrated in swine herds of Kansas and Indiana showing mummified fetuses and late abortions. Isolation of the agent is being attempted.

The Committee wishes to express its appreciation to B. W. Hawkins, Administrator of APHIS, USDA, for his efforts in establishing the National Reference Center for Leptospirosis at Ames, Iowa. This Committee's members give special thanks to the continuing efforts and support given to the establishment of the Center to the National Cattlemen's Association, the National Pork Producers Council, the American Association of Veter-
inary Laboratory Diagnosticians, the American Leptospirosis Research Conference, and the American Veterinary Medical Association. These groups and the Committee on leptospirosis recognized the urgent need for the establishment of the Center.

The establishment of this Center follows nearly a decade of effort by this Committee with support of these organizations in justifying the need for such a Center in the United States. This Committee recommends that the USDA continue to apprise the USAHA of its progress in implementation and the fulfillment of the epidemiologic, diagnostic, and research needs of the livestock producers, practicing veterinarians, and state and federal regulatory agencies in the prevention, diagnosis, and control of leptospirosis in the United States.
EXPERIENCES AND PROGRESS TO DATE IN OPERATING A STATE
MASTITIS CONTROL PROGRAM

Leslie A. Wager, DVM, Director
New York State Mastitis Control Program

I would like to thank Dr. Jordan and members of his committee for giving me the opportunity to speak today on the New York State Mastitis Control Program. The topic he gave me was to include the problems and progress with a state program. First I would like to tell you a bit about our program and what we are trying to accomplish.

Our program started in 1946 as a branch of the Veterinary College at Cornell University. I had just started in dairy practice then and began to use the Mastitis Control Program right away and continued for the next twenty plus years. Five laboratories were located throughout the state. Each was staffed with a veterinarian and a second person who did laboratory and secretarial work. Our work force has grown since then and we now have approximately forty-five employees. Each lab is headed by a field veterinarian and together with three to five field technicians they conduct mastitis surveys. Each facility has one or two laboratory technicians and a secretary who processes reports, handles accounts receivable, etc. The administrative offices are located in Ithaca as is the research facility where all of the mycoplasma testing is conducted.

The backbone of our program is the mastitis survey and culture work that follows. Requests for surveys come from practicing veterinarians, dairymen, extension workers or milk plants. Our state Department of Agriculture and Markets has written into the Abnormal Milk code a regulation that stipulates when a dairy’s bulk milk exceeds the one-million somatic cell count level for two consecutive counts, he must have a survey and work with our program for at least six months. Field technicians visit the dairy farm and all cows are examined for abnormal secretion and an aseptic sample of milk from all lactating cows is collected. Primarily we take composite samples, that is all four quarters in one sterile vial. We run a California Mastitis Test (CMT) at cow-side on several cows, mainly to show the dairyman what the somatic cell level is and thus the production and economic losses he is incurring. Clinical findings and any CMT scores are recorded on the survey report. After the cows are sampled we complete a detailed milking machine and management questionnaire. Eventually bacterial findings will be recorded on the survey report by the laboratory technicians.

While mastitis is basically a bacterial infection, several other factors play a major role and we take a close look at these. It is very important with controlling this disease that milking and management practices be right. We prefer to set these factors straight before we go after the mastitis-causing organisms. (Fig. 1)

Most milk samples arrive at the laboratory on the same day they are taken and are plated onto blood agar containing 0.1% esculin. Next, a CMT
is run on that same composite sample and this score is used in the preparation of the cow grouping report. On indicated samples, an antibiogram is run using the Kirby-Bauer sensitivity test. A wide range of antibiotics are used and results are reported as resistant, intermediate or sensitive. Culture data is summarized on the summary report. (Fig. 2) Copies of this report are sent to the cooperating veterinarian and the dairyman. This data is also put into the computer.

We prepare another summary, mainly for use in the field, that shows at a glance the culture picture in a herd and the damage that the infections are doing. In this summary the cows are grouped according to culture and CMT scores. Dr. Robert Bushnell at the University of California at Davis, showed this scheme to me years ago and we have used it and find it extremely helpful. This summary tells us 1) the cows that are giving high cell milk, 2) if we can expect help from antibiotics, 3) where efforts should be directed, 4) length of time expected to make progress, and 5) whether progress is or is not being made. All cows fall into at least one of the ten columns. (Figures 3 & 4)

The Mastitis Control Program field veterinarian reviews the culture results and the milking and management data from each survey. He/she has at his/her fingertips everything needed to make recommendations, be it therapy or management changes or whatever. A written report is sent to the dairyman and his practicing veterinarian.

A conference is held on farms exceeding the one million somatic cell level after the reports have been sent. This is our “Team Approach”. The Mastitis Control Program veterinarian, the practicing veterinarian, the milk industry inspector and others who frequently join may be the Ag. & Markets representative or the milking machine dealer, attend the meeting. The entire herd situation is discussed and a plan to improve udder health is made. This meeting eliminates the breakdown in communications which has happened so often in the past.

We promote prevention. We are trying to make dairymen aware of how cows develop udder infections. Infections are mainly caused by bacteria and bacteria originate in two places: 1) the infected udder, or 2) the cow’s environment. This is where bacteria come from and to prevent new infections, we must: 1) reduce exposure of bacteria in and around the teat end, and 2) prevent penetration of bacteria into the gland.

In addition to personal contacts, we are trying to spread the word by other means, such as radio programs, newsletters, student teaching, seminars for veterinarians and dairymen, training sessions for veterinarians and technicians and activities through the Empire State Mastitis Council and the National Mastitis Council. We also have a series of brochures all written in laymen’s language. (Fig 5)

As to progress, we definitely think we are forging ahead on a statewide basis. We felt comfortable, and of course encouraged, the reduction of the somatic cell level to one million nearly two years ago. We are now excluding milk at the one million level and not much is being dumped. The one
million level is easy when you have the “tools and know-how”. On an individual herd basis, we make great strides in most cases. Our program together with an interested dairyman and a knowledgeable veterinarian is an unbeatable team! Some dairymen have fallen by the wayside; mainly those unwilling to make changes. As in any business, one must react to changing times.

There is no program without it’s problems. We have encountered the following:

1) Failure of all parties working with dairymen to tell the same story and stress the importance of basics of mastitis control, such as sanitation or proper milking techniques.

2) Apathy and disinterest on the part of some dairymen, with the attitude towards mastitis that “everyone has it” or “you cannot get rid of it”.

3) Some practicing veterinarians are only “treatment oriented” and fail to work on the basics. We stress that mastitis is a preventable disease and it “cannot be controlled through the tip of a syringe”.

4) Staffing a facility can be a problem, however qualified and interested veterinarians are available. All technicians must have adequate backgrounds but go through “in house” training. Our employee turnover is low.

5) Finally, funding certainly can be and has been a problem, but we now have that one well in hand. We know we have a good program, one that works and that is valuable and in demand. We charge for our services and we think it is the best disease-prevention dollar the dairymen can spend. Our Department of Agriculture and Markets feels we are rendering a needed service and they support our budget of over one million dollars by about 40%. The remaining 60%, we earn, primarily from fees charged the dairymen. We charge two dollars per head for composite samples plus a twenty-five dollar service fee, for each survey. For an example, a survey on a 100 cow herd would cost the dairyman $225.00.

Thank you for your attention, and if any of this interests you and you want to know more about our program, please feel free to contact me. Or better still, visit New York State.
Figure 1
FACTORS INFLUENCING UDDER HEALTH

Milking Equipment
(Design, Installation, Operation & Maintenance)

Milking Procedures & Milking Sanitation

Sanitation
(Environmental and Milking Equipment)

Housing, Ventilation & Environmental Conditions

Herd Replacements

Nutrition

Other Stress Factors
(Over-crowding, High Production, Stray Voltage, etc.)
**NEW YORK STATE MASTITIS CONTROL PROGRAM**

**Summary Report**

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**Survey Initial, Resurvey, Research, Extension, Miscellaneous**

**Sample type**
- Quarter
- Composite
- Bulk Tank only
- Myco only

**Number cows sampled**

**Cows**

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<th>Abnormal Secretions</th>
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**BULK TANK**

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**Comments**

Prepared by ________________ NYSMCP Veterinarian ________________
### New York State Mastitis Control Program

**Figure 3**

**COW GROUPINGS BY CULTURE RESULTS & CMT SCORES**

(See reverse side for explanation)

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**Figure 4**

**INTERPRETATION OF COW GROUPINGS**

**COLUMN 1 -** These cows show excellent udder health. Over fifty percent (50%) of the herd should fall into this group. Most or all of the 1st calf heifers should be in this group as well.

**COLUMN 2 -** Culture negative, however CMT scores are high. Observe these cows closely. They are in this group because: 1) They may have been treated with an antibiotic within the past three weeks which may cloud the laboratory results, 2) They may actually be infected with Staphylococcus aureus or coagularchs but these organisms are not constant shedders and may not have been shedding into the milk at the time of sampling, 3) They may be infected with Mycoplasma which requires special tests for detection, or 4) They may not be currently infected but have lower than ideal udder health because of a past injury (mechanical or pathological) and the tissue is in a healing phase.

**COLUMN 3, 4 and 5 -** Cows infected with Streptococcus agalactiae. Column 3 shows low CMT scores and indicates new or very few infections. Column 4 has high CMT scores and indicates chronic or well established infections. Both groups usually respond well to a single regimen of treatment with an effective antibiotic. Column 5 shows cows infected with both Strep ag and Staphylococcus aureus. The Strep ag will respond to antibiotics but the Staph aureus may not (See column 6 & 7 and the fact sheet on Strep ag.)

**COLUMN 6 and 7 -** Cows infected with Staphylococcus aureus. Staph aureus can cause a severe and persistent mastitis that tends to resist treatment and cows will frequently fluctuate between the clinical and subclinical states. New or less severe infections appear in column 6, with column 7 representing the well established or chronic cases. Treat only cows showing clinical signs. For best results, use at least three infusions at 12 hour intervals.

The level of Staph aureus should be under five percent (5%) and no Staph aureus in the herd is a realistic goal. This type of mastitis is man-made and may reflect problems with milking equipment, milking procedures and overall management. See fact sheet on Staph infections and dry cow management.

**COLUMN 8 -** Cows infected with staphylococci species. This is a less virulent form than Staph aureus, however it can cause a severe mastitis at times. Treat only clinical cases. Most herds have this type to some degree and infections will often disappear spontaneously. When the percent of this type is high, especially if the CMT scores are elevated, look for problems with milking equipment, milking procedures or sanitation. (See fact sheet on Staph infections)

**COLUMN 9 -** Cows infected with streptococci species. There are several different types included in this group. Some will cause a severe but transient mastitis that responds well to treatment, but some (especially the Group 5 strep) are very resistant and require vigorous treatment (three infusions at 12 hour intervals). A high level (over 20%) of strep infections is usually associated with poor environmental sanitation (wet, dirty, unsanitary stall beds, and/or muddy barnyards) teat injuries, using infusions too long, poor design and maintenance of housing, too high or too low vacuum levels. Steps should be taken to correct all of the above deficiencies. Some of these infections will disappear spontaneously through the cow's own natural defense mechanism. Dry treat with an effective product.

**COLUMN 10 -** Other infections. These are primarily gram-negative types such as E. coli and Klebsiella and mastitis caused by these range all the way from subclinical to a severe acute systemic syndrome sometimes resulting in death. Prompt treatment by a veterinarian is imperative in all acute cases. See fact sheet on coliform mastitis. Clinical mastitis caused by other organisms in this group usually will not respond to treatment and must be culled. Among these are Pasteurella, Nocardia, C. Pyogenes, Proteotheca and Mycoplasma. Antibiotics are contraindicated in Yeast infections and many will disappear spontaneously in four to six weeks. Some with elevated CMT scores means the infection is exciting a response in the cows system and the end result is loss of milk production. When clinical signs are absent in these animals, this is what is meant by subclinical mastitis.

<table>
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<tr>
<th>a) CMT Scores</th>
<th>Approximate relationship of CMT Scores &amp; DHI Somatic Cell Counts</th>
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<td>CMT N-T = equal or less than 500,000 cells</td>
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<td>CMT 1-3 = greater than 500,000 cells</td>
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All with elevated CMT scores means the infection is exciting a response in the cows system and the end result is loss of milk production. When clinical signs are absent in these animals, this is what is meant by subclinical mastitis.

prefix = 1st calf heifer
prefix = non-functioning quarter
* means clinical signs on day of survey.

6/81 NYSMCP
Figure 5

NEW YORK STATE MASTITIS CONTROL PROGRAM

Brochures

NYSMCP Description

Streptococcus agalactiae Mastitis

Staphylococcus aureus Infections of the Bovine Udder

Coliform Mastitis

Somatic Cells in Milk

Milking Equipment — Conventional Pipeline Milking Systems

Good Milking Practices and other Suggestions to Reduce

Udder Infections
Thank you, Mr. Chairman, it's a pleasure to be here this morning to discuss with you the National Residue Avoidance Program. Without any further introduction, I believe it would be appropriate for us to view a narrative slide series on residue prevention prepared by the U.S. Department of Agriculture, aimed at dairy farmers and dairy producers for the purpose of providing information and education on the importance of preventing residues in milk and meat products. After viewing this narrative slide presentation, I believe you will see the importance of the National Residue Avoidance Program. (NOTE: At this point the slide presentation was initiated, accompanying this and attached to this speech is a copy of the narrative slide presentation for publication in the USAHA proceedings.)

The purpose of the National Residue Avoidance Program is to develop a coordinated information and educational program for producers of all species of livestock which will serve the purpose of preventing residues from occurring at the farm, thus minimizing the rate or incidence of adulteration of milk and meat in our food supply. If we can prevent residues from occurring at the farm level, we can improve marketing efficiency and prevent economic losses for producers.

Another basic purpose of the National Residue Avoidance Program is to bring industry and government together in a cooperative effort to reduce residues in cull cows and "Bob" veal calves. Of course, as always, our continuing concern is the prevention of mastitis, the most costly of all animal diseases of importance to the dairy industry. The presentation by Dr. Wagner, describing the New York Mastitis Control Program and the presentation you will hear tomorrow of the Nebraska Mastitis Control Program are two examples of the kind of model programs which the National Residue Avoidance Program hopes to utilize in developing comprehensive information pertaining to the avoidance of residues. It is important for a national coordinated program to be developed that will be applicable to problems in each species and yet will have the ability to rely on a common data base of information which can be utilized by individual producers to solve specific problems on the farm.

At this point in time, we are assembling information from a number of research projects being funded through the Food Safety and Inspection Service and the Extension Service. In the dairy sector, for example, there are approximately 13 projects now being funded at various land grant institutions throughout the nation.

Coordination is being achieved through the National Residue Avoidance Task Force which is comprised of producer representatives from each
major animal species sector. A Washington-based Steering Committee carries out the overall policy and guidance established by the Task Force. Both government and industry are represented and have expressed a real desire to cooperate in formulating a comprehensive program.

Finally, we do not need more regulation to solve our residue problems. What we need is more awareness and willingness on the part of the majority of producers to prevent problems from occurring. We need regulation only to keep those who would willfully intend to adulterate food honest. To repeat what Dr. Wagner said, "You can't control mastitis at the tip of a needle." Such a statement is apropos in describing the intent and purpose of the National Residue Avoidance Program. Again, it's been my pleasure to be here today to talk about this subject with you. Thank you, Mr. Chairman.
Residue Prevention... The Key to Wholesome Milk and Meat

A slide show narrative guide
This slide show was prepared by the U.S. Department of Agriculture to introduce its Residue Avoidance Program.

Drugs and chemicals can improve production, but they must not remain in milk or meat. By taking extra precautions, dairy farmers can avoid accidental contamination and help assure the safety and wholesomeness of the food supply and avoid financial losses.

Violative residues can poison products and lower consumer confidence in the safety of certain foods, making sales drop. Prices fall, and farmers lose money.

Working to prevent residues, the U.S. Department of Agriculture tests meat and poultry for drugs and chemicals.
When a violation is found, the carcass is condemned. Producers are notified and their next animals are tested before leaving the slaughterhouse.

But there's a better way to guarantee a food supply safe from residues ... that better way is prevention.

That's why USDA has joined producer organizations, veterinarians, and the Cooperative Extension Service in the ... Residue Avoidance Program.

Residues can be avoided when producers build in safeguards at key points, to catch contamination before milk or meat enters consumer channels.
Just as tributaries flow into a river, contributing to its make-up -- feed, drugs, water, and chemicals can nurture or contaminate animals.

These slides show how sound management -- practiced from the animal's birth until slaughter -- can prevent accidental contamination and residue problems, and enhance the marketability of milk and meat.

A good starting point in the check for contaminants is the feed. What you know about its origins is important.

For instance, if you spray a field of corn with pesticides, those chemicals may find a way into your animals.
Whether you buy commercial mixes or mix your own feed, it's important to know what's in each ingredient.

Buy grain, hay, and forage from reputable sellers with a history of safe handling of pesticides.

Or, have samples tested for residues at a reputable laboratory before the feed goes to animals.

To help trace back any problems that do occur, save samples and record the source, lot number, dates received and used, and the identity of animals getting the feed.
For accuracy and speed, some farmers have moved from written records to computerized ones.

Proper handling of medication is a second step in residue prevention:
Read and follow directions on all medications.
Each time a new package is opened, read the label because dosage or withdrawal period may have changed since the last time you used it.

Keep records on medicines and animals treated:
Record medication name, lot number, withdrawal period, and treatment dates.

Identify which animals receive drugs.
Assign only one person to give drugs. Train that person in proper drug management.

A trained person is not likely to accidentally overdose animals ... or give drugs that have withdrawal periods to calves or cull cows being sent to slaughter.

Reading labels on all products used near farm animals is one of the simplest yet most effective ways to prevent contamination and residues ... from hazardous pesticides, paints and wood preservatives.

Some pesticides, for example, are so long-lasting that they can leave a barn permanently unfit for milk or meat production.
If you need an insecticide, ask your veterinarian or an Extension Agent to check its safety. Dairy specialists have two charts for dairy farmers, one on fly control, the other on antibiotics. Both are available from the National Milk Producers Federation.

The fly control chart lists chemicals for back rubbers, dust bags, and ear tags.

The important rule with pesticides and drugs is to strictly follow manufacturer's instructions. And consult your local Cooperative Extension Service and veterinarian, concerning the safety of all products used on or around your animals.

In addition to reading labels, these precautions help avoid residues:

- Don't re-use containers.
- Clean up and pick up
- Dispose of empty containers properly. Follow label instructions. Some states have sites for toxic wastes, ask your local Extension Agent for advice.
Filling an empty container or sprayer with a different product can lead to accidental substitution of one substance for another ... and that leads to contamination.

"Clean up and pick up" barbed wire, broken glass, and nails ... anything that can injure animals. Injuries cause infections ... which require drug treatment. Preventing infections cuts down on drug use and drug residues.

A sanitary barn also deters disease from insects, rodents, and other sources.

Consider everything around your animals as a source of contamination ... especially when you build or remodel. Ask the question: Could this material, paint or preservative create a residue problem?
Planning includes selecting the site for animal housing and making sure the water comes from a safe source.

This well shaft is sealed with concrete to keep water free of contamination.

Be sure run-off water from feedlots, lagoons or holding tanks doesn't enter the water supply. Concrete walls prevent run-off.

Design buildings that are easy to clean.
Build facilities to separate sick and well animals. Hospital pens can help control the spread of infection and make treatment and record keeping easier.

Construct an area for newborn calves. A clean, dry, draft-free shelter is essential for calf survival.

USDA inspectors report a serious increase in the number of young calves they condemn at slaughter because the carcasses have high levels of antibiotics and sulfas.

Bull calves can thrive without drugs ... but like heifers they need care ... to be healthy ... to gain weight ... and bring more at auction. Colostrum, the first milk or fluid after freshening, helps prevent infections. Hand feeding lets you know how much the calf actually drinks.
Colostrum from older dams contains more antibodies than that from a cow freshening for the first time. Freeze colostrum from an older dam that freshens normally ... that is ... after the withdrawal period for dry treatment.

If you must give an antibiotic or sulfa to a veal calf, do not market it, until the withdrawal period ends -- 10 to 15 days for most drugs, but 30 days for a sulfa bolus.

If calves leave the dairy farm during the withdrawal period, they can still have violative levels of drugs at slaughter, because 90% of bull calves are slaughtered before they are one week old.

Only a few calves are fattened for fancy veal or milk production ... but, producers of fancy veal pay a premium for healthy young calves weighing about 100 pounds.
Everyone benefits from healthy veal calves -- dairy farmers, truckers and dealers, auctioneers ...

meat packers ...

and ... consumers.
While medications are important on modern farms, they cannot replace sound management which emphasizes disease prevention ... for cull dairy cows as well as veal calves.

Dairy farmers have shown that drugs can be used to treat cull cows on the farm without violative residues in carcasses at the slaughterhouse.

Before USDA stepped up testing for antibiotics -- with the swab test on premises or STOP Program -- industry and government explained the problem, and provided tips on using drugs properly without residue problems.

Immediately, dairy farmers took action. Proper use of antibiotics -- including strict attention to withdrawal -- has meant fewer violations.
Violation rates for cows fell from 3.7 percent in 1978 to 6-tenths of one percent in 1981 and 1982 -- that's one-sixth of what it was. The cooperation of many -- dairy farmers, veterinarians, drug manufacturers, associations, extension agents and government -- made violations decline.

Now dairy farmers or their veterinarians can perform the same test on urine from LIVE cows ... and know overnight whether the cow is ready for market.

The test is done with bacteriological plates. Cotton swabs (laboratory type Q-tips) are dipped into urine, put on a plate, and incubated over night.

Antibiotics interfere with bacterial growth. When there are no antibiotics present, bacteria grow right up to the swab tips ... like the plate on the right. A negative test plate means the cow is ready to market. But, antibiotics in the urine stop bacterial growth, leaving clear areas around the swab tips like the plate on the left. A positive test means residues still linger in the kidneys and meat. With a test like the one on the left, re-test the cow in two or three days.
The test is explained step-by-step in a new USDA guidebook.

For a copy of the guide and a tape cassette, write to FSIS Information, Room 1163-South, U.S. Department of Agriculture, Washington, DC 20250.

Technological breakthroughs like the swab test can detect residues only after the fact ... preventing residues takes planning and actions every day, at every stage.

Once dairy farmers build residue avoidance into their management system, contamination of milk and meat can be avoided. Thus, consumers will be assured that our abundant food supply remains safe and wholesome. And consumers can have greater confidence in the safety of the meat and dairy products they buy.
The Nebraska approach to an effective Mastitis Control program is a five-phase approach. The five phases are:

I. Organization and Involvement
II. Educational Meetings
III. Establishment of 32 Demonstration Herds
IV. Initial Findings of the Demonstration Herds
V. Follow-up Activities

The primary objective of the program is to motivate and train all persons associated with the dairy industry in the state to comprehensively deal with this costly disease. The first four phases of our program have been completed. We are presently in phase five.

PHASE I
Organization and Involvement

In order to accomplish the objectives of our program it was evident that all the resources available in our state needed to be utilized effectively. Five departments and eleven staff members agreed to give a high priority to this program. In addition, four nationally known authorities, including Dr. W. Nelson Philpot, agreed to assist in our overall effort as needed. Key industry people including representatives from cooperatives and cheese plants, county Extension agents, equipment dealers, Head-State Department of Dairies and Foods and veterinarians were contacted. All agreed to cooperate and support our program.

Dr. W. Nelson Philpot was employed to help develop and headline our program. His first assignment was to present a two-day seminar in May of 1979 to update our staff, industry fieldmen, sanitarians, veterinarians and equipment dealers on the latest information available on mastitis cause/control/prevention. His program was recorded and used as reference for development of the program for our December 1979 Area Dairy Days. Our group agreed this would be the common base for our program. This seminar was the catalyst which initiated the enthusiasm which has prevailed throughout the entire effort. It helped instill confidence in everyone involved that an excellent program could and would be forthcoming in the fall. Involved staff members made a commitment to put on a comprehensive two-week program covering all aspects of mastitis. Dr. Philpot was scheduled to appear on the fall program in the summary and wrap-up position. He helped write the summary for the program which then became the outline for development. Dr. Philpot's role in establishing

1Extension Dairyman, Extension Veterinarian, Extension Agricultural Engineer, and Extension Dairyman, respectively, University of Nebraska, Lincoln, NE 68583.
the confidence of industry people toward our program was as valuable, if not more valuable, than his headlining our meeting program.

The change of the manufacturing milk law which became effective in 1980, made all markets more concerned than ever about the mastitis problem. Because our staff promised to provide a comprehensive educational program for patrons in all parts of the state, all market outlets agreed to underwrite the production of this program on a pro rata basis. This amounted to a contribution of $1.50 per patron selling to their plant. In addition, they agreed to pay for meals for their patrons attending the meetings. This amounted to a total pledge of over $20,000 in support of our program. All markets were also assured a voice in developing the program by participating in meetings of the planning and review committee. The fieldmen helped in running meetings, moving equipment and program materials from meeting to meeting and selling advance registrations.

Directly and indirectly involved in planning, promoting and carrying out the educational phase of the program were the following:

- 80 dairy plant fieldmen
- 100-200 dairy women in 11 chapters
- 15 sanitarians
- 5 university departments
- 11 university staff members
- 1 guest lecturer
- 30 county agents directly
- 30 county agents indirectly
- 14 milk market owners or managers

We also involved all facets of the state’s dairy industry in a six-month promotion program. Promotion efforts were coordinated by one of our TEAM members plus a staff member of the University of Nebraska Agricultural Communications Department. All media techniques were used. In addition to television, radio and press, all markets cooperated using direct mail and personal letters. The fieldmen and dairy women’s promotion organization set up a one-on-one direct contact campaign. Every dairyman in the state was exposed to from three to eight promotional contacts relevant to this program. Some reported as many as eight separate contacts. For extra identification of this program, a special logo was designed and used throughout this campaign (Figure 1).

Figure 1. Examples of logo developed for use in Nebraska mastitis control program.
Advance registrations were sold by county agents, fieldmen, dairy women's organizations and sanitarians. The dairy women's group purchased books to be used at the meetings at an educational discount and sold them at retail price. This gave them a money-making project ($1.00 per $5.00 registration) as well as helping to provide the industry an opportunity to obtain more educational information in dealing with the mastitis problem. Although the county agents and sanitarians sold a few registrations and a few came through the mail, the fieldmen accounted for 20-30% of the sales and the dairy women the other 50-60%. The one-on-one contact by these people, who were provided with complete promotion information packets, was a primary reason for the good turnout by producers. This procedure made many people an integral part of the program.

PHASE II
Educational Meetings

The educational meetings which were phase II of our program, were held in December 1979. Because of a tight budget for travel, limited staff time, and a need to reach remote areas of the state a tape/slide/conference telephone network approach was selected as the means of delivery for our educational program. (Note: This technique is particularly pertinent at this time as the new National Mastitis Council slide set by Dr. W. Nelson Philpot is quite applicable to this approach.) Meetings were conducted at the locations shown on the map in Figure 2.

Figure 2. Locations of 1979 Area Dairy Days mastitis meetings.
The program topics were as follows:

Day 1: Mastitis - An Overview
      The Mastitis Program
      What Mastitis Cost You
      What is Mastitis
      Feeding and Mastitis
      What To Do About Mastitis
      Mammary Gland: Structure and Function
      Milking Management and Mastitis
      Engineering Aspects of Mastitis Control

Day 2: Udder Sanitation
      Mastitis Detection
      How to Treat Mastitis
      Control of Specific Infections
      How to Handle the Problem Herd
      What Field Trials Tell Us
      Money Returns

All program visuals were reviewed by our TEAM and a member of our Agricultural Communications Department staff and then were reproduced by that department for us. Our TEAM along with industry persons critiqued each speaker's outline and made suggestions for eliminating overlap and omissions, plus plugging holes. The prepared program was then critiqued before it was put on tape and slides for final review. Ten sets of tapes and slides were produced. Each tape/slide set consisted of about 750 slides and six hours of tape. These were produced at the following cost:

- Duplication and collating: $155.00
- Preparation and art work: 50.00
- Tapes: 10.00
- Trays: 45.00

Producing ten (10) sets cost $260.00 per set, or $43.00 per hour, providing one slide each 30 seconds. All or part of these tape/slide sets are available to anyone desiring to use them.

By having the entire program on synchronized tape/slide sets we were able to conduct simultaneous meetings at different locations on the same day. In our case, up to six meetings were conducted per day. Two types of meetings were conducted. The primary or "live" meetings were those at which most of the presentations were delivered "live." The others were termed "satellite" meetings where the presentations were presented in total via tape/slide sets. For the larger meetings speakers were used on the tape players to provide the necessary volume. The Wallensak tape recorder and speakers were also used as the amplifier for the conference telephone at the large meetings. The necessary equipment was readily available as all of our county extension offices have Wallensak tape recorders and Kodak Carousel slide projectors. The conference telephones were loaned by the University and moved from location to location with the tape/slide sets or rented locally.
The delivery system was relatively trouble free, other than a few tapes breaking. These were mended on the spot and the program resumed. Command slides were used for persons running the program, instructing them to change tapes, change slide trays, etc. We had county agents and fieldmen hosting and running the satellite programs.

Starting times for all meetings were synchronized. This was necessary so that a minimum of time lapsed between the end of the presentations and the beginning of the question-answer period. The time from the end of a session to the beginning of the question-answer session was used to accumulate the questions on cards and make any necessary announcements.

The conference telephone network was used to link all meetings for questions and answers. We had a one and one-half (1½) hour session in the morning and another in the afternoon each day. After each 1½-hour session the live meetings were linked with the satellite meetings for a live question-answer session. Persons at all locations asked their questions which were then answered by the speakers at the live meetings. The conference telephone allowed all persons to hear all questions and answers regardless of their location. Arrangements were also made to have staff members, who were located at Lincoln and could not attend all meetings, be in their offices and on the conference telephone line to answer questions which were within their area of expertise. This allowed our research-teaching people who had schedule problems to participate in our program.

All conference telephone calls originated at the University of Nebraska switchboard. A test hookup was established before the morning program each day and used as an orientation period for people at the satellite locations and provided an opportunity to answer any questions from persons running the meetings. The conference call for each question-answer session was established about twenty (20) minutes before each half-day session was scheduled to end.

During the question-answer session persons at each location could ask questions using the microphone of the conference telephone. The question would then be answered by the appropriate speaker. Two or three questions in a row were all that were allowed from any location at one time. This procedure resulted in a continuous rotation between all locations. The interaction was excellent and most morning sessions were shut down for lack of time. Any remaining questions were carried over to the afternoon sessions. The cost for the conference telephone call question-answer session was about $4.00 per thirty minutes per location.

Our experience indicates the conference telephone system requires at least one individual who is very familiar with the operation of the equipment. Also every location needs a backup telephone so that conservation regarding problems which develop can be accomplished while the network is being established. We established two conference calls per day at each of the fifty (50) meetings. We lost partial communications only twice out of over one hundred (100) contacts during the two-week period.
The phone system intrigued people and the interaction of dairymen separated by up to 400 miles added appeal. The conversation became more relaxed on the second usage and the conference telephone developed a “warm personality” by the second week.

The result of this effort was that about one-third (1/3) of the dairy farm families, producing an estimated two-thirds (2/3) of the state’s milk supply were represented at the fifty (50) meetings held at twenty-five (25) locations in twelve (12) days. In addition, many persons in support roles pertaining to mastitis were educated at the same time. Following are the statistics showing educational hours of instruction and educational materials distributed:

<table>
<thead>
<tr>
<th>No. Persons</th>
<th>Seminar</th>
<th>Exchange</th>
<th>Meetings</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 Univ. of Nebraska Staff</td>
<td>20</td>
<td>10</td>
<td>8</td>
<td>418</td>
</tr>
<tr>
<td>60 Dairy Plant Fieldmen</td>
<td>20</td>
<td>8</td>
<td>1,680</td>
<td></td>
</tr>
<tr>
<td>30 County Extension Agents</td>
<td></td>
<td>8</td>
<td>240</td>
<td></td>
</tr>
<tr>
<td>12 State Dept. of Agriculture</td>
<td></td>
<td></td>
<td></td>
<td>336</td>
</tr>
<tr>
<td>1400 Dairymen and Family Members</td>
<td>20</td>
<td>8</td>
<td>11,200</td>
<td></td>
</tr>
<tr>
<td>25 Veterinarians</td>
<td>8</td>
<td></td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>15 Dairy Equipment Dealers</td>
<td>8</td>
<td></td>
<td>120</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14,194 hours</td>
<td></td>
</tr>
</tbody>
</table>

**Educational Materials Distributed**

<table>
<thead>
<tr>
<th>Per Person</th>
<th>Total Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 books</td>
<td>3000</td>
</tr>
<tr>
<td>4 circulars</td>
<td>5600</td>
</tr>
<tr>
<td>3 mimeos</td>
<td>4200</td>
</tr>
<tr>
<td>9 pieces each</td>
<td>12,300 total</td>
</tr>
</tbody>
</table>

This is a total of 160 pages of material per person.

The tape/slide/conference telephone system also made it possible to schedule many more locations than normal and in areas where travel would not be justified because of the low concentration of dairymen. The dairymen in these areas are interested in educational programs but frequently do not have ready access to meetings because of distance.

For evaluation purposes, a survey was sent to a random sample of participants of which eighty-five percent (85%) have responded. Survey
results indicate about one-fourth (¼) of our audience was made up of
dairymen who had not previously attended extension meetings and an-
other one-fourth (¼) had attended fewer than three (3) extension meetings
in the past. Thus, we set out to reach a new audience and did so.

PHASE III
Establishment of 32 Demonstration Herds

After the educational meetings, a demonstration herd approach was
proposed as the best procedure to further our awareness program. For this
effort, additional grant money was necessary if we were to set up enough
herds to be effective.

At a dairy Extension Advisory meeting, board members of Mid America
Dairymen Inc., Central States Division, asked what we needed to carry on
the program. A grant of $30,000 was subsequently obtained from their
organization to cover our needs. These monies were to be made available if
we determined that sufficient interest existed among dairymen to make
such a project possible. Partially as a result of this grant we were sub-
sequently able to obtain further monies in the form of a research grant
from University of Nebraska calf scour royalty funds to do additional
analysis work which will yield research data on our findings.

Selection of the herds which would be participants in the demonstration
herd phase of the project began by sending a letter to about 450 of the
dairymen who had attended both parts of our two-day educational meet-
ings asking if they would be willing to cooperate with a University TEAM
on a 3-year Mastitis Control Project. Approximately one-half (225) re-
turned cards indicating they would be interested.

Our TEAM then established the following criteria for eligibility in the
program. The dairyman would agree:

1. To pay a $300 subscription fee with the stipulation that it would be
   returned if the dairyman remained on the program for the full three
   years.

2. To obtain the signatures of his fieldman, veterinarian, and equip-
   ment dealer pledging their cooperation with the dairyman and the
   recommended practices prescribed by the UNL TEAM on this proj-
   ect.

3. To become or already be a member of a DHI program. Dr. Al Bringe,
   Wisconsin, Dr. Larry Heider, Ohio State, recommended this stipu-
   lation based on their experience showing that milk production is the
   ultimate response the dairyman will value, although lowered so-
   matic cell counts and better udder health are important.

4. To keep and maintain individual cow health records.

5. To dry cow treat all cows, all quarters, teat dip with an approved
   product, treat clinical cases at least three days with a recommended
   product, consider culling certain cows if recommended by the TEAM
   and check equipment each six months.
6. To cooperate on our computer ration balance program. This requirement was based on data from Dr. Larry Heider's work in Ohio where it appeared poor nutrition limited production response in spite of lowered somatic cell counts and better udder health.

7. To attend 4 to 6 educational meetings in the next two years.

8. To allow us to use collected data for research and educational purposes.

9. To host educational barn meetings, if requested.

10. To share project costs as follows:

<table>
<thead>
<tr>
<th>The Program Responsible For:</th>
<th>The Dairyman Responsible For:</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) The original survey (including the equipment check and recommendations)</td>
<td>a) All subsequent equipment checks, repairs and purchases</td>
</tr>
<tr>
<td>b) Cultures and analysis of milk samples</td>
<td>b) Cost of collecting milk samples</td>
</tr>
<tr>
<td>c) Recommendations by the veterinarian on the UNL TEAM</td>
<td>c) Running CMT's on all cows each 6 weeks during the first six months</td>
</tr>
<tr>
<td>d) Computer ration balancing</td>
<td>d) All treatment and veterinary bills</td>
</tr>
<tr>
<td></td>
<td>e) Feed sample collection and analysis</td>
</tr>
</tbody>
</table>

Herd size, milk production level, somatic cell count and geographic location were considered as additional criteria for eligibility but were not used in the final selection.

When the 225 interested producers were offered the above criteria, allowing one week for response, forty indicated they were still willing to participate. Of these, 32 were selected. This decision was made to balance participating herds with the time and resources available from the UNL TEAM.

Telephone contact and follow-up letters were sent to all veterinarians that had accepted control program responsibilities. We stated the importance of having knowledge of a Modern Mastitis Control Program.

Specific responsibilities were cited as necessary to perform as a cooperator's veterinarian:

1) Examine udder and teat ends, record if abnormal.
2) Collect a four quarter composite milk sample for culture.
3) Supervise or perform all treatments on clinical cases.
4) Perform mastitis tests on new herd additions.
5) From laboratory results as to the organism causing the infection, prescribe procedures and control measures to correct:
6) Maintain contact on program progress and provide consultation concerning mastitis and general herd health.
7) Advise owner on keeping records current and accurate in coordination with the UNL TEAM.
Participating veterinarians were urged to attend meetings on the Mastitis Control Program when provided for the cooperators. All veterinarians also were reminded of the great potential this program could have as a practice-builder with spin-off advantages.

Bacterial analysis consisted of examining milk samples by standard bacteriological and culturing techniques. A part-time technician was employed to assist with the laboratory analysis. Control measures recommended varied as to pathogen type and cow numbers infected.

Another technician was hired to conduct the field survey of all the herds following direct supervision and training by the TEAM. Steve Spencer, Pennsylvania, was employed to assist in developing field survey procedures and forms and to provide guidance in evaluation of field data.

In addition to general observations regarding cow handling and housing facilities, and milking system performance parameters, the field survey included the following:

1) Observation and recording of good or poor procedures that could affect udder health.
2) Products and techniques used to treat mastitis.
3) Animals marked for identification.
4) Animals not permitted to stand in farm ponds, stagnant water or mud.
5) Breeding records and mastitis records being kept.
6) Sterile equipment used for infusing each quarter.
7) Use of cowside tests on farm.
8) Final rating of milking routine survey: Excellent; Adequate, Fair, Poor.

Reactions and cooperation have been good from all segments of the industry associated with this project. One-on-one discussions have been held with each cooperator and educational meetings have been conducted on milking system design and performance evaluation and veterinaries’ procedures and practices.

PHASE IV
Initial Findings on the Demonstration Herds

The on-site survey of the 32 demonstration herds was conducted over a three month period (June to August 1980). Data and observations were recorded by the technician who was instructed to be candid, frank and thorough in his observations and notations. He was also instructed not to offer other than very basic evaluation comments. Evaluation of the data and preparation or recommendations were performed by TEAM members on the University faculty.

In an effort to obtain a “feel” for each installation, both written comments and sketches were utilized in addition to completion of the project survey form. Among items reviewed were space per cow, housing venti-
lation, cleanliness and maintenance of free-stalls or resting facilities, number of units per operator, line sizes, cow preparation procedures and overall milking technique. Checks were subsequently made of such milking system performance parameters as pump and system airflow rates, regulator response and extraneous voltages. These on-site survey results were complemented by forge analyses plus CMT scores and aseptic samples for each cow. A synopsis of the results of each survey area follows.

Facilities/Milking Systems

1. Cooperator herd sizes ranged from 30 to 180 cows.
2. Free-stalls were provided on about 2% of the farms. Maintenance of free-stall bases and dividers were judged to average between fair and good. Cow refusal rate was very high in some cases due to a general state of disrepair and free-stalls which were too short and/or too narrow.
3. Open or dry lots are generally well maintained with minimal debris and wet spots. A common problem, however, was letting soil work away from the edge of concrete aprons resulting in ledges of up to 18 to 20 inches which cows had to negotiate.
4. All cow resting/feeding areas were presumably non-mechanically ventilated. However, in most cases, structural features necessary to achieve good ventilation by non-mechanical means were absent.
5. Watering devices tend to be poorly maintained leading to potential for DC voltage development and limited water intake.
6. Of the 32 demonstration installations the distribution of milking systems was: 15 herringbones, 8 side-opening, 2 walk-thru, and 7 milking barns or flat parlors. Of these, about 80% feed some grain in the milking area.
7. High milklines are predominant (75% of installations).
8. Only a small proportion of the cooperators utilize automatic detachers (3) or technology to reclaim heat released in the process of cooling milk (4).
9. Most systems have appreciable losses of airflow capacity due to leaks and/or restrictions. Only two systems had system vs. pump airflow capacities with differences of 10% or less. The range was 3 to 48%.
10. Milklines are frequently installed with less than the recommended slope and with more than the recommended number of units per slope for a given pipeline size.
11. Vacuum regulators are generally performing poorly. Over 2/3 of the regulators checked did not control vacuum levels within 0.5" Hg of the setpoint at system loads (airflow rates) of 0 to 90% of system capacity. The range of vacuum level drops was 0 to 2.8" Hg.
12. Over 50% of the farms surveyed had extraneous voltage levels (AC or DC) in excess of 500mv somewhere within the milking center.
Based on surveys of over 80 farms to date a voltage of 200 to 300mv appears to be a baseline or normal level for Nebraska dairy installations.

Milking Procedures
1. Cow preparation was an area of major weakness. Twenty-five percent of the producers were still using cloths or sponges to wash the udder. In 13 herds udder preparation was being done without the benefit of a sanitizing solution. The practice of post-milking teat dipping is followed by all producers.
2. The most common errors during the actual milking operation were pinching the air hose to sense milk flow (9) and failure to shut off vacuum before removing the teat cups (12).
3. Based on records of prep time, lag time (end of prep sequence to unit attachment) and unit “on” time, there appears to be a moderate amount of over-milking. In several herds, the lag time exceeded two minutes.
4. Dirty milking equipment was found on 9% of the herds.
5. The cows in seven herds had access to ponds and/or streams. In two cases cows were purposely granted access to ponds during hot weather to minimize hot weather stress.
6. Cow handling procedures were judged as “gentle” in all cases.
7. In only 10 situations was it reasonably practical to milk cows with mastitis last. Of those, only two followed that practice.

Veterinary Procedures
1. Most producers do at least minimal foremilking.
2. In general, clinical mastitis cases are treated promptly — with approved products.
3. *Staphylococcus aureus* is the predominant infective organism.
4. *Streptococcus agalactiae* was found in a few cows in 20% of the herds.
5. *Streptococcus uberis* and *Streptococcus dysgalactiae* were cultured from a small percentage of the cows.
6. Dry cow treatment is an accepted practice in all herds for nearly all cows.
7. In only two herds were facilities and management such as to allow separation of infected cows and to allow milking of heifers first.
8. Culling is still a difficult choice in many herds. The problem is compounded in herds where 20 to 30% of the cows are infected.
9. A high proportion of first-calf heifers are infected with mastitis producing organisms.

Ration Formulation
1. While rations were generally well balanced, comparison with computerized recommendations indicated that at least one important
improvement was possible in nearly all rations.

2. Energy, protein, phosphorus and salt were two primary ration factors evaluated. In the rations analyzed, energy was low in 52% and high in 16%; protein levels were high in 36% and low in 32%; phosphorus was okay in 84% and low in the remaining 16%; and 36% were low in salt.

3. Forage analyses indicated some very good to excellent hays on hand.

PHASE IV
Follow-up Activities

Expanded Mastitis Control Program — Success of the 32 demonstration herds in reducing mastitis levels and increasing production stimulated interest among dairymen not on the program. For monetary reasons the initial expanded program was based on user fees. The expanded program was open to any dairyman in the state. For a fee of $25 a pre-check data submission survey form was analyzed and an evaluation returned to the dairyman. The evaluation provided preliminary information concerning possible problems with the milking equipment and basic milking procedures. Subsequently the producer was offered the opportunity to have a follow-up on-site visit where more extensive testing and evaluations were made. The on-farm service included an evaluation of cow handling, housing facilities, milking procedures, veterinary practices and a thorough equipment operation analysis. Fees for the on-site work included a $100 base price plus a $30 stop charge. Patrons who were not shipping to milk markets helping to underwrite the program were assessed an additional fee of $170. Producers shipping to participating markets (those markets helping to underwrite the cost of the program) paid their service fees through a milk check withholding by the milk market.

In getting ready for the expanded program a second series of educational programs was held. Meetings were conducted at 27 locations over a five day period. A combination of one live speaker, video tape and synchronized slide/tape sets and the conference telephone for question-answer sessions were used at each location. Attendance at these meetings was approximately 900. An additional 1200 producers were reached through a slide/tape presentation at the district meetings of one milk marketing cooperative.

To help carry out the requirements of the expanded mastitis control program a full time field representative technician was employed and trained to perform the on-site surveys, prepare reports on the findings of the survey and send them to the individual dairyman. The field representative was trained and supervised by the UNL TEAM.

After 14 months this phase of the expanded program has been discontinued. The technician who was trained and carried out this phase of the program resigned to become a franchised milking equipment dealer. Upon review of the program, we concluded that with the procedures developed,
experience gained and training received by equipment dealers, veterinarians, fieldmen and electricians (local teams) that we would not replace the technician. Our emphasis instead, would be on providing printed mastitis control guides and training local teams to use the implement and maintain effective mastitis control programs for their local producers. The UNL TEAM will provide backup assistance and training for the local teams. A monthly mastitis newsletter has gone to every dairy producer and some 300 other interested producers every month for the last three years.

Program Results — Survey results indicate we have been able to achieve approximately an 82% increase in the use of the practices advocated as part of a mastitis control program. Survey information does not permit evaluation of how well these practices are being employed but only that they are being used. Somatic cell counts were obtained for the year preceding our meetings, on the herds represented in the mail survey. Comparison of S.C.C. levels during the year preceding our meetings and the year following the meetings indicated an average reduction of 100,000 or 20%. This translates into over a million dollars in savings by the 1200 dairy farms represented at our meetings, as represented by the sample.

Lower S.C.C. levels indicate reduced mastitis levels. Benefits are reflected in increased milk production per cow. Nebraska dairymen increased average milk production per cow during the second year of the program by 4%-two times the national average. This infers that reduced mastitis has resulted in significant milk production increase due to the Nebraska mastitis control program.

The new demonstration herds have made even better progress. The organisms causing mastitis in the demonstration herds have been primarily staphylococcus aureus. Only a few infections caused by streptococcus agalactiae were found and they have been eliminated. A 33% reduction in the number of cows infected in these herds has been accomplished. Iodine levels have been reduced from 546 ug per liter to 349 ug per liter. The herds have reduced somatic cell counts by over 40% and increased average milk production per cow by 1191 lbs., and butterfat by 47 lbs. per cow in the first 2 years of the scheduled 3-year program. This means an approximate increase in net profit of $156.00 per cow per year. In the latter instance the rolling herd average increased from under 16,000 lbs. to nearly 19,000 lbs. Somatic cell count levels in several herds were over 1,000,000 at the start of the program and are under 300,000 now with several being under 100,000. All of the high (over 1,000,000) S.C.C. herds were under 600,000 after 2 years.

Veterinarians throughout the state have worked very closely with the TEAM on the project. Greater producer interest has increased requests for local veterinary assistance. The potential for improving their practice is obvious and they are providing better service. In addition, other clients requesting this service will benefit by their improved expertise.

FUNDING

In addition to funds through the University of Nebraska normal edu-
cational channels, outside funding in excess of $250,000 has been pledged. This funding has come through the milk marketing system. Some has been directly through grant funds to help carry out educational programs and to underwrite the expanded mastitis control program. Some support has also been indirect. Examples include assistance in paying for meals at producers' meetings and purchase of educational materials.

A grant was also received from the University of Nebraska Calf Scour Vaccine Royalty Fund to help conduct additional research on the demonstration herds. This research included identification and changes in mastitis pathogenic organisms, incidence and magnitude of extraneous voltage on Nebraska dairy farms, and incidence of iodine residue in milk products.

EVALUATION

The success of the Nebraska mastitis control program is believed to be due to the team effort and a number of other factors. Among those are:

1. Voluntary assembly of the team. There were no administrative mandates for this task to be undertaken, thus, the total program evolved as the result of interest on the part of the individuals.
2. Multi-faceted approach to solving the problem. This was evident in our educational materials and meetings.
3. Similarity in views and goals of team members.
4. Sharing of authority and responsibility. We have no "chiefs" and no "Indians." We are all "warriors" out to engage in battle to reduce the incidence of mastitis.
5. Dedication of the individuals cooperating on the project. A sincere, dedicated approach has been clearly evident throughout the program.
6. Mutual respect for the technical expertise of each team member.
7. Assurance that each individual has responsibility for a specific part of the program. Each part of the program is an integral part of the total.
8. Advisory inputs. Throughout our program we have solicited input and guidance from nationally recognized experts, university administrative personnel, industry representatives and dairymen themselves. Although influenced by these groups, final decisions regarding the total program have been made by the TEAM.
9. Establishment of reasonable, realistic and attainable guidelines and goals for individual dairymen.
10. Regular meetings. Throughout the program the UNL Core Team has met one-half to one full day per month. Additional time was scheduled as necessary for program development. This continual contact and persistent effort to get things done not only has resulted in each of us receiving moral and technical support from other team members but has also helped us to realize where we were deficient
in the total effort. We remained cognizant of the jeopardy to the total effort if we did not carry through with our assumed responsibilities.

11. Total industry involvement. We included the entire dairy industry in the educational effort from the very beginning. Consequently, everyone involved in the production of good quality milk—whether they have a direct vested interest or not—has felt a part of the total effort.

12. Flexible goals. We have not lost sight of our primary program goals. At the same time, our interim goals have remained flexible to allow tailoring of the program to ever-changing and evolving needs.

13. Demonstration herd program. This has clearly demonstrated that with proper attitude on the part of the dairyman and a concentrated effort, success can be achieved regardless of herd size, location or milking system. We feel a smaller group of demonstration herds would have resulted in far less respect and success in the total program.

14. Local teams. Rather than attempt to carry the program ourselves we have continually tried to improve mastitis control by upgrading the expertise of local teams (veterinarians, equipment dealers, fieldmen, county agents and the dairyman). We feel that only by full accomplishment of this approach can the program create strong long-lasting statewide impact.

SUMMARY

The Nebraska mastitis control program has shown that in interdisciplinary approach can be used effectively to minimize a problem as complex as mastitis. Flexibility and dedication of the participants, industrywide involvement, and a comprehensive total management approach are seen as vital ingredients. Further, new and perhaps novel educational program delivery techniques can be used effectively.

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AN INTERDISCIPLINARY EFFORT THAT'S WORKING


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REPORT OF THE COMMITTEE ON MASTITIS

Chairman: Dr. Clarence A. Jordan
Vice Chairman: Dr. John S. McDonald
Clerk: Mr. John Adams

J. B. Adams, DC; R. W. Bennett, GA; A. N. Bringe, WI; Robert Bushnell, CA; Charles Emerick, WA; Thomas Fuhrmann, AZ; Carl Graham, MO; Francis Gregerson, CO; D. E. Jasper, CA; C. N. Jewett, AR; C. A. Kirkbride, SD; W. E. Lyle, WI; Ray Mykleby, ID; T. G. Murnane, Mexico, DF; R. S. Sechrist, OH; F. E. Sterner, CO; G. H. Swenson, MI; D. U. Walker, VT; R. F. Weidner, IL; D. J. Kubik, NE

Attending: Dr. Edward Slerner, CO; Dr. Max O. Crandall, MD; Dr. Charles Dobbins, GA; Dr. F. J. Alderink, MD; Dr. John E. Post, CT; Dr. Don J. Kubik, NE; J. S. Hayden, NO; Dr. Gene H. Swenson, MI; Dr. Myron Brown, KS; Joan M. Arnold, WI; Dr. Nancy East, CA; Dr. Mark Thurmond, CA; Dr. Charles Emerick, WA; J. Wade Groff, PA; Dr. Robert B. Cohen, NY; Dr. William B. Bixler, MD; Dr. Rufus F. Weidner, FL; Francis D. Gregerson, CO; Dr. Donald A. Gable, MD; Dr. Roland S. Jeans, MI; Dr. Thomas Fuhrmann, AZ; Dr. Darrel E. Johnson, WI; Dr. Leslie A. Wager, NY; Dr. G. W. Meyerholz, DC.

The November 10, 1982 committee report was approved as read. The goals developed in past years were reviewed and the following progress reported:

1. Strengthened our working arrangement with the three other national committees by:
   a) Continuing to play an active role in the Joint Mastitis Committee made up of representatives of U.S.A.H.A., N.M.C., A.V.M.A. and the A.A.B.P. attending a meeting of that group while at the National Mastitis Council meeting February 1983 where we distributed Drug Residue Avoidance guidelines, Drug withdrawal time charts and the do’s and don’ts of Drug Residue Avoidance.
   b) We attended and participated in the February ’83 meeting of the A.V.M.A. Mastitis committee with Dr. Derral Johnson, their chairman, reciprocating this Monday afternoon, by attending our meeting where he distributed A.V.M.A.’s “Recommended Minimal Standards of Performance For Practicing Veterinarians Who Offer Mastitis Control Programs.” He reviewed proposed revisions to theses standards. He invited comments from the members of our committee.

2. Continued our study of Mastitis Control programs by:
   a. Our committee member, Dr. Charles Emerick, outlined his procedures in the conduct of his veterinary practice specializing in mastitis control and eradication as well as the operation of his
own 200 cow dairy herd. He emphasized that cleanliness of all parts of the cows environment, proper maintenance and operation of the milking equipment including back-flushing, proper milking procedures followed by teat dipping and infusing the udder of the cow at drying off time, were absolutely necessary in any mastitis eradication program. He advised culturing individual cow samples from all cows in a problem herd followed by dividing the herd into a clean group and infected group with continuing of the treatment and culturing of the infected group to decrease its size.

b. We reviewed Dr. Leslie Wager’s paper “Experiences and Progress to Date In Operating a State Mastitis Program” and Dr. Don Kubik’s paper “Our Mastitis Control Program in Nebraska,” an extension based program which you will hear tomorrow morning, after which we had an open discussion comparing the two.

c. Dr. Nancy West of the University of California listed the needs of the Goat Industry in Mastitis control. She reported that there are over 20,000 milk goats in California alone with mastitis infections similar to cattle but in different percentages. She stated that many of the control problems were similar but the “Hard Udder” syndrome needed more study as well as the development of a serological test for the presence of Mycoplasma mastitis in goats which can be very devastating to the herd. Mr. Francis Gregerson, committee member and Director of the Mountain Empire Dairy Cooperative reported that their Monetary Incentive Milk Quality program of 8 cents extra per c.w.t. is continuing to be very successful. It was the consensus of the committee that the Monetary Incentive Milk Quality programs of the various co-ops and proprietary handlers are very necessary to successful mastitis control programs and more such programs should be encouraged. We asked our representative on the N.M.P.F. to take on this responsibility.

3. In dealing with our search for new mastitis remedies, Dr. Gene Swenson of the Upjohn Company spoke on the use of lactating mice in the study of the efficacy of various drugs as infusion treatments for mastitis. He stated that as many as 80 mice could be both inoculated intra-mamarily with mastitis causing bacteria and treated intramamarily for mastitis in a two hour period thereby greatly decreasing the time and expense of developing new mastitis infusion products which in turn should encourage drug companies to make this effort. John Adams of the National Milk Producers Federation reported that the present strict budget restraints has decreased the amount of money being spent on Mastitis research but we should continue to encourage such research wherever possible.
4. John Adams reviewed the formation of the present “National Residue Avoidance Program” emphasizing that the program is stressing education of the meat and milk animal owner using regulation and penalty only when absolutely necessary. He stated that mastitis is the most common disease that can leave drug residues behind it with any decrease in the incidence of mastitis producing a corresponding decrease in drug residues. Dr. Charles Dobbins reviewed the work they are doing in the University of Georgia evaluating the “Live Animal Screening Test” known as LAST. He described how an animal owner could build an inexpensive incubator and assemble the necessary equipment for use in conducting this test for drugs on urine and or milk from the live animal as well as tissue swab from the organs of an animal being butchered for food. It was agreed that the goals of the committee for the coming year should be to:

1. Continue to work closely with the Mastitis committees of the other three National organizations and participate in the joint committee meeting to be held in conjunction with the National Mastitis Council.

2. Continue to encourage more states to develop Mastitis programs with reports to be developed for our 1984 meeting.

3. Continue to encourage drug companies to develop new and more effective infusion products.

4. Make printed material available for the education of U.S.A.H.A. members in Mastitis control.

5. Encourage dairy cooperative and proprietary handlers to update their present quality programs adding a monetary incentive whenever possible.

Respectfully submitted,
Clarence Jordan, Chairman
RESIDUES — THE VETERINARIAN’S DILEMMA

Charles N. Dobbins, Jr., D.V.M.
Head, Extension Veterinary Department
and Associate Dean, College of Veterinary Medicine
The University of Georgia
Athens, Georgia

One of my concerns about the sulfonamide or antibiotic residue problem has been the lack of a method for veterinarians or producers to check their animals for residues prior to marketing. As a producer, it is a little disturbing to receive notification of sulfonamide residues when you think you’ve been doing everything right.

Well, at “LAST” there is a safe, economical, stable test available to veterinarians and producers that would enable them to check animals prior to marketing and identify those with sulfonamide or antibiotic residue problems. This test is called the Live Animal Swab Test or “LAST.” With a maximum investment of $12.00 a veterinarian or producer could be in a position to check individual market hogs or groups of swine for the presence of sulfonamide or antibiotic residues. The cost of materials used in each test would range from 5¢ – 90¢ depending upon the volume of tests conducted.

The Food Safety and Inspection Service for several years has been using a swab test on carcasses after slaughter. This test was known as the Swab Test on Premises, “STOP.” The “LAST” test is very similar; in fact, the only difference is the concentration of spores in the test suspension. The “LAST” test is currently recommended for testing urine in live animals. The idea being when the urine is free of antibiotics, the tissue levels have also decreased and the animal can be safely marketed. The “LAST” test may also be used on body tissue such as liver and kidney as well as other body fluids — serum, whole blood, saliva, milk, as well as urine. When these other body fluids are used for the test, one must be careful in making interpretations, because antibiotic and sulfonamides are cleared from these body fluids before they are eliminated from the liver and kidney. Information is not available as to the exact time lag for each major drug and species of animal. In the case of milk, judgement may be made prior to the completion of a withdrawal period; however, in general, the “LAST” test is recommended to be performed only after antibiotics have been drawn for the prescribed period. Further evaluation must be made before exact recommendations can be made utilizing these other body fluids.

In addition to the “STOP” and “LAST” tests, there is another swab test to check for antibiotics or sulfonamides in feeds. The feed test, however, utilizes a different organism and a different incubation temperature.

Details of the test are available in Agricultural Handbook No. 601 entitled, “How to Perform the Live Animal Swab Test for Antibiotic Residues.” You may obtain a copy from your County Extension Agent, Extension Animal Scientist, Extension Veterinarian, or by writing the
U.S.D.A. Food Safety and Inspection Service Washington, DC 20250. This reference lists all materials needed, how to perform and interpret the “LAST” test. With about 10 minutes instruction, any high school student would be capable of performing this test. By next fall, there will also be a tape to accompany the booklet as well as a slide set with an accompanying tape.

The test consists of a vial of *B. subtilis* spores suspended in alcohol, a petri dish of antibiotic No. 5 media, a 5 microgram neomycin disk, plus an incubator that can be made from a styrofoam box, a fish tank heater and a thermometer. A pair of tweezers or small forceps and a flat ruler marked in millimeters completes the essential equipment.

The test is designed to be conducted on urine of the test animal, however, since it is somewhat difficult to collect urine samples from swine, we are currently studying the feasibility of using serum, whole blood, or saliva.

Handbook No. 601 describes a method of disconnecting the heating element from the aquarium heater and wiring light bulbs to the thermostat for a source of heat in the incubator. We have found that using the aquarium thermostat and heater as it comes from the discount store ($6.00) is completely satisfactory. We have not had a problem with breakage of the protective glass covering.

As of the end of September 1983, the Extension Veterinary Department in cooperation with 12 pilot counties and other Extension Specialists have logged approximately 20,000 samples tested since mid-February. These tests include samples from swine, turkeys, dairy cattle, cull cattle, goats, chickens, spent fowl, both before and after slaughter. Urine, serum, whole blood, saliva, milk, feed grains, by-product meal, as well as body tissues from the various species have been tested. The Georgia Residue Avoidance Program also checks for other residues such as mycotoxins, pesticides, and heavy metals (arsenic and lead).

We have been pleasantly pleased that the level of residues encountered has been extremely low. Our sample size from any one group or premise consists of five animals.

Approximately 325 feed samples and/or animals out of 20,000 tests have been found to be positive, however, upon closer evaluation, in the case of the positive withdrawal feed samples, none of the animal tissue from those farms showed any indication of antibiotic or sulfonamide residues. Since it is legal to have up to 50 grams of some antibiotics in withholding feed, perhaps this finding is not too surprising. Apparently there is not enough antibiotic at this low level to spill over into the tissues.

In some of the cases of positive animals, it was found that many of these animals had positive urine but negative kidney tests. Perhaps this too is not surprising since this is the normal way the body excretes antibiotics and sulfonamides.

In a few cases, where only one of five animals showed indication of antibiotic or sulfonamide residue, it was felt that faulty laboratory technique had been used in handling the neomycin disks with probable con-
tamination of the cotton swabs. In some instances, only one of five animals were positive, so we had a situation where a few more hours before slaughter would probably result in all tests being negative.

To date, there has been only three incidents of all animals from a group tested showing evidence of antibiotic or sulfonamide residues. On voluntary traceback, in one case, it was found that an error on the farm occurred when an antibiotic containing feed was mistakenly placed in the bin serving the market-ready animals.

Since we have been doing multiple testing, we have attempted to simplify the testing procedure by substituting Schleicher & Schuell No. 740-E, ½ inch Analytical Paper Disks for the cotton swabs. This technique saves quite a bit of time, money, and hopefully will make the tests easier to use. For example, in the future, you may be able to collect samples by taking a pair of tweezers or forceps and wetting the analytical paper disks with saliva or a drop of blood from each of the five animals per farm or group. The paper disk would be air dried and mailed to your local veterinarian or to a central laboratory for overnight testing. However, at the present time, if you are only interested in conducting an occasional test on five or ten animals, it would probably be best to continue using the cotton swab method.

We have also found that there is an unidentified substance in serum and milk that may inhibit the growth of B. Subtilis spores similar to an antibiotic. The substance can be inactivated by heating serum and milk samples in a water bath prior to testing. These false positive tests are perhaps better than false negative tests.

Antibiotic and sulfonamide residue violations are costly to producers not only because of the condemnation of the animals but through the disruption of the production process and possible decreased sales. On the other hand, by following label directions, using common sense management, careful planning and the use of the inexpensive “LAST” test, antibiotic and sulfonamide residues in food animals can be reduced to a minimum.

Do not expect the Live Animal Swab Test used prior to marketing to eliminate all positive samples taken after slaughter. The “LAST” test does not appear to be as sensitive as the laboratory test used on officially collected samples.

On the other hand, by withholding any positive “LAST” samples a few more days until they clear, one would expect the level of residues to be reduced.

The current action level on sulfonamides is 0.10 ppm. Many of the violative levels fall in the 0.12 ppm – 0.15 ppm range. Perhaps by using the “LAST” test on the farm, we can eliminate violative levels in the higher ranges. Who knows, perhaps a slightly higher action level may be more realistic.
RESULTS "LAST" FIELD TEST AS OF SEPTEMBER 30, 1983

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</tbody>
</table>

<sup>a</sup> Only 3 bonified cases of 5 positive animals from a single premise has been found to date. Figures include known positive samples used to test the program, multiple samples from positive animals, clinical cases from diagnostic laboratories and samples where only one out of 5 pigs from a single premise were found.  
<sup>b</sup> Kidney tissue samples from the same animals were negative.  
<sup>c</sup> It is legal for feeds to contain up to 50 grams/ton of certain antibiotics - tissues from animals.  
<sup>d</sup> Two known positive samples.  
<sup>e</sup> Samples from mastitis laboratory - not market milk -- 111 positive samples using the swab test while only 67 showed positive on stearothermophilus test on same samples. Upon placement of positive swab tests samples in hot water bath only 68 remained positive.  
<sup>f</sup> Cattle not destined for slaughter. Most positive serum samples will show negative upon placement in hot water bath.  
<sup>g</sup> Clinical cases from diagnostic laboratories - not for slaughter purpose.  
<sup>h</sup> Low background levels of arsenic and lead detected.
REPORT OF THE COMMITTEE ON ENVIRONMENTAL RESIDUES

Chairman: G. D. Osweiler, Ames, IA
Vice Chairman: W. B. Bixler, Rockville, MD

John Adams, DC; H. D. Anthony, KS; F. M. Applehans, TN; D. S. Beck, KY; D. M. Bedell, GA; W. B. Buck, IL; S. J. Cougar, TX; C. R. Dorn, OH; G. T. Edds, FL; H. M. Frederick, VA; R. A. Gessert, VA; H. S. Gosser, GA; Carl Graham, MO; J. W. Howder, WA; C. S. Johnson, TX; F. R. Robinson, IN; D. G. Rollins, MO; J. L. Shupe, UT; T. M. Wilson, PA

The Environmental Residues Committee met October 19, 1983, with 11 members present. Five reports were heard.

1. Dr. William Bixler, Bureau of Veterinary Medicine, reported on the establishment of an office of Voluntary Compliance and Operations. This gives formal recognition to a program designed to help increase compliance with the Federal Food, Drug and Cosmetic Act by the regulated industry through utilization of information and education efforts. The intent is to better assist industry in regulating itself. This approach has been especially valuable in conjunction with efforts of the National Renderer’s Association.

Dr. Bixler reported that the past year has presented relatively few problem residue incidents, although halogenated hydrocarbons continue to occur as a major portion of residues. Potential for aflatoxin contamination in 1983 was reviewed.

2. Activities of the National Renderer’s Association were reviewed by Dr. Fred Bisplinghof. The National Renderer’s Association has developed a program of testing and educational activities to prevent inadvertent contamination of animal byproducts. A toxic and hazardous chemical committee has been formed to deal with problems on a continuing basis.

3. Dr. Lea Kennedy, Chief of the Animal Feed Safety Branch, Bureau of Veterinary Medicine, reported on specific investigations of the Bureau. A pentachlorophenate contamination was detected and traced to a biocide used in a sheep pelt fleshing operation. A cooperative information campaign was used to reach other hide processing, tanning, and rendering firms.

4. A residue avoidance program in Georgia was described by Dr. David Bedell. The Live Animal Swab Test (LAST) was used as a screening procedure to detect antibacterial residues in tissues and fluids of food animals. From approximately 20,000 samples only a small percentage had potential violative antibacterial activity. Greatest incidence of activity was among swine with approximately 3 percent positive reactions.

5. Dr. Howard Frederick, American Feed Manufacturers Association, reviewed Arizona work in progress evaluating aflatoxin residues in
dairy cattle. The ratio of feed to milk contaminated with aflatoxin B₁ and aflatoxin M₁, respectively is being evaluated. Preliminary results indicate that the present 20 ppb feed level ceiling for dairy cattle should provide a substantial margin of safety for avoiding M₁ residues in milk.

Discussion within the committee was concerned primarily with aflatoxin concerns, as well as potential for other mycotoxin contaminants in moldy feeds and animal products. There is concern that numerous potential problems related to molds and mycotoxins should be more vigorously pursued in agricultural research. After discussion, a resolution to this effect was developed by the committee for submission to the Resolutions Committee of United States Animal Health Association.

Meeting adjourned at 4:10 p.m.

I move this report be referred to the Executive Committee for approval.

Respectfully submitted
Gary D. Osweiler
CURRENT RESEARCH ON FOREIGN ANIMAL DISEASES
IN THE UNITED STATES

by
H. Graham Purchase
National Program Staff
USDA-ARS, Beltsville, Maryland

Animal agriculture in the United States is a $120 billion industry with exports of $4 billion. U.S. livestock are free of many diseases which occur in livestock of other countries of the world and which we shall define as foreign animal diseases (FAD). Imports of animals and animal products amount to approximately $2.5 billion annually. Each animal (or animal product derived from an animal) that is imported poses a risk to U.S. animal agriculture, no matter how small that risk may be. However, there is far greater risk of importing an FAD when animals or animal products are imported from a country in which diseases foreign to the United States are enzootic and when imported meat and meat products do not meet import requirements. The number of animals, slaughtered products, and travel-related items imported into the United States are presented in Table 1.

With the increase in worldwide tourist travel, there is an ever-increasing risk of importing FAD on passengers’ shoes, in baggage, and in aircraft and marine garbage. For example, African Swine Fever virus can be imported in cured pork; hence, this product is confiscated when found by customs inspection. Also, dangerous disease-contaminated materials, such as cured animal products and even pig heart valves for transplantation into humans can be imported through the mails. Often neither importer nor exporter recognizes the potential danger of introducing an FAD by way of their actions. Regulations have been promulgated and customs inspections are conducted at our borders specifically to intercept as many as possible of these potentially dangerous imports. Some indication of the extent of interception or noncompliance with entry requirements of animal products and travel-related items is given in the “high risk” column in Table 1.

The responsibility for preventing and detecting the entrance of FAD into the United States rests with the federal government, in particular the U.S. Department of Agriculture. The main laboratory for making the diagnoses is the Plum Island Animal Disease Center. The center has diagnostic competence for most of the FAD that have been identified (Table 2), and scientists there have, during the last 30 years, conducted research on most of the diseases. However, research is needed to improve most of the diagnostic tests so that the presence of disease agents can be detected rapidly (preferably in a matter of hours), inexpensively, and by procedures applicable to large numbers of samples. Research is also needed on many aspects of the diseases other than on diagnosis only. For example, our knowledge of some of them is insufficient to gauge precisely how much of a
threat they pose to the U.S. livestock industry. For some of the diseases, we
do not yet have diagnostic competence.

The national dialogue continues on the roles of federal agencies and the
states in research. Foreign animal diseases are generally considered a
national concern; and, therefore, the federal government should have a
major role in their research. However, in some states—particularly at the
state universities—some individuals have specific expertise and interest
in FAD. These universities and individuals could shoulder some of the
responsibility for FAD research.

To roughly estimate the future needs for FAD research and diagnostic
needs in the United States, a search was made of the Current Research
Information System (CRIS) for 44 diseases which have been identified as
FAD (Table 2).

METHODS

The CRIS is an automated system for storing and retrieving information
on research projects of the U.S. Department of Agriculture (USDA) and the
state agricultural experiment stations (SAES). The data base consists of
over 24,000 resumes of current or recently completed projects sponsored or
conducted by 55 SAES, 30 forestry schools and other cooperating insti-
tutions, and 6 agencies in the USDA. The latest complete data base
available is for fiscal year (FY) 1981.

The title, text, and keywords were searched for each of the 44 FAD listed
in Table 2. This information and progress report for each of the 287 records
retrieved were then reviewed, and estimates were made of the proportions
of research directly and indirectly related to FAD. There were 92 records
erroneously retrieved that did not relate to research on FAD. By use of a
short computer program, the proportion of research directly or indirectly
related to each disease was multiplied by the funding and scientist year
(SY) effort on each project. These were accumulated and are printed in
Tables 3 and 4.

Projects were classified as directly related to FAD if scientists were
working directly with a foreign disease agent, a foreign serotype of a
disease agent, or, in the case of influenza viruses, working with a highly
pathogenic agent. Projects were classified as indirectly related if domestic
agents in some way applicable to FAD agents were used, domestic vectors
were studied without using the FAD agents themselves, statistical analy-
ses were performed, hemoparasites closely related to hemoparasites of
food-producing animals (e.g., Trypanosoma cruzi) were being studied, or
FAD agents were used for purposes unrelated to the disease caused by the
agent (e.g., using vesicular stomatitis virus for interferon assay).

RESULTS

A summary of the funds used for research in the Agricultural Research
Service (ARS) and in the SAES on each FAD is presented in Table 3. Of the
$11,156,628 associated with research directly related to FAD, 95.2 percent
was used in ARS and 4.8 percent in SAES. Of the $4,616,497 associated
with research indirectly related to FAD, 40.4 percent was used in ARS and 59.6 percent in SAES. Total research on FAD amounted to $15,773,125.

Of the 34 scientists directly involved in research on FAD, 92.9 percent were in ARS and 7.1 percent in SAES. Of the 26.3 scientists involved in indirect research, 35.4 percent were in ARS and 64.6 percent in the SAES.

The funding per scientist on FAD was $328,136 for direct research and $175,532 for indirect research.

The distribution of research effort by state and country is shown in Table 4. Research in Kenya is included because one USDA scientist and a support person are based there. Only 24 of the 50 states have FAD research, and only 7 states have more than one SY of effort when federal support and state support are combined. Only four states support more than one SY in state institutions.

DISCUSSION AND CONCLUSIONS

The data base used in this study was for a single year, namely FY 1981, and is 2 years old. It may be incomplete, particularly in the reporting of FAD research. For example, some of the research may have been conducted by universities overseas and may not have been reported in CRIS. Also, some nonfederally funded institutions, such as the research department at the Zoological Society of San Diego, conduct significant research on FAD and do not report their research activities in CRIS. No consideration was given to research by industrial organizations. The data presented in the tables are only approximate, having been roughly estimated to the nearest 10 percent for each disease and based solely on the title, approach, most recent progress report, and keywords. The proportion of research effort in the laboratory on a particular disease does not necessarily relate to the proportion of the progress reported on that disease. For example, much effort and resources could have been expended on a project which was not reported in CRIS and so could not be retrieved for this study. Thus, there are clearly limitations on the ability of a search of CRIS to reflect exactly the amount of FAD research being conducted. However, these figures obtained from CRIS do serve as a rough estimate of the amount of research conducted on each FAD in FY 1981.

As would be expected, significantly more research directly related to FAD was conducted at federal facilities than at state facilities. Federal facilities for FAD are the Plum Island Animal Disease Center, Greenport, NY; the Arthropod-Borne Animal Diseases Research Laboratory, Denver, CO; the Hemoparasite Research Unit, Pullman, WA; and the Southeast Poultry Research Laboratory, Athens, GA. The preponderance of research directly on FAD in the federal government is likely due both to the availability of federal facilities and expertise and to the major role of the federal government in this type of research. However, more research indirectly related to FAD was conducted in the SAES than in ARS, confirming the ability of the SAES to do this type of research. Research indirectly related to FAD fits better with the SAES mission to solve regional and local problems. These figures clearly show the role of the
federal government in direct research on FAD and the role of the SAES in research indirectly related to FAD.

The cost of research per SY for research directly related to FAD was almost double that for research indirectly related to FAD. This observation would be expected because of the types of facilities, such as those needed for high-level containment and activities needed for conducting research directly related to FAD. For both research directly related to and indirectly related to FAD, the cost of research per SY was higher in ARS than in the SAES. There are many reasons for this. In ARS, expenditure of funds is at the agency level and includes all overhead for facilities and ground maintenance. Another reason is that at the teaching universities, the number of SY often includes recent graduates, and in some instances research is done during teaching or extension functions.

There is no question about the great benefit derived from research already conducted: the United States has been free of foot-and-mouth disease for over 50 years and has successfully eradicated 12 infectious diseases which caused enormous economic losses to our livestock industry prior to their eradication. Nevertheless, we must be constantly on guard to prevent the introduction of these diseases into our livestock populations; and, to assure that these diseases are not introduced, we must upgrade our technology as rapidly as possible. An active research program to improve our understanding of the diseases and to improve our diagnostic tests is the only way to improve our ability to exclude FAD. Even though research on FAD is relatively costly, research expenditures are a very low fraction of the direct and indirect costs that would be incurred if an FAD is introduced.

Only 22 of the 44 FAD’s were being researched in the United States in FY 1981. Of those 44, there are 9 for which diagnostic competence has not yet been attained. Whereas we believe that most of the diseases that are not being researched are of minimal threat to the U.S. livestock industry, in many instances, rapid diagnostic tests are not yet available. This unavailability increases the possibility that the diseases would not be detected in the United States until they have spread extensively. Thus there is an urgent need for additional research on these diseases.

Table 1. Entries into the United States: Risks of importing foreign animal diseases (FAD).

<table>
<thead>
<tr>
<th>Item</th>
<th>High risk</th>
<th>Low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of lots or entries</td>
<td></td>
</tr>
<tr>
<td><strong>Live animals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td>124</td>
<td>659,607c</td>
</tr>
<tr>
<td>Horses and asses</td>
<td>1,230</td>
<td>13,396c</td>
</tr>
<tr>
<td>Chicks</td>
<td>N/A</td>
<td>2,784,926c</td>
</tr>
<tr>
<td>Sheep</td>
<td>0</td>
<td>6,860c</td>
</tr>
<tr>
<td>Swine</td>
<td>0</td>
<td>145,695c</td>
</tr>
<tr>
<td>Pet birds</td>
<td>19,145</td>
<td>778,080</td>
</tr>
<tr>
<td>Zoo animals</td>
<td>42</td>
<td>0</td>
</tr>
<tr>
<td>Slaughter products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat and meat products</td>
<td>6,807 lots</td>
<td>33,552 lots</td>
</tr>
<tr>
<td>Commercial animal products</td>
<td>2,854 lots</td>
<td>83,655 lots</td>
</tr>
<tr>
<td>and byproducts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel related entries e</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passengers</td>
<td>8,740</td>
<td>57,151</td>
</tr>
<tr>
<td>Baggage</td>
<td>104,238 Lots</td>
<td>745,090,000</td>
</tr>
<tr>
<td>Mail</td>
<td>6,995 Lots</td>
<td>649,775,000</td>
</tr>
<tr>
<td>Aircraft garbage</td>
<td>2,649</td>
<td>278,783</td>
</tr>
<tr>
<td>Marine garbage</td>
<td>5,717</td>
<td>68,219</td>
</tr>
<tr>
<td><strong>TOTAL RISKS</strong></td>
<td>158,541</td>
<td>1,399,774,924</td>
</tr>
</tbody>
</table>

a High risk indicates a higher risk that animals, products, or baggage contain FAD agents than low risk animals, products or baggage. It includes animals being required to enter through quarantine stations, slaughter products refused or restricted entry into the United States, passengers' shoes requiring disinfection, baggage or mail seized, and garbage disposals requiring correction.

b Low risk includes animals entering through channels other than quarantine stations; slaughter products permitted entry; passengers, aircraft and marine arrivals, and all baggage and mail.

c Figures for fiscal year (FY) 1981; all others are FY 1982.

d Not applicable.

e Sources of information include the Animal and Plant Health Inspection Service, the Economic Research Service, the Customs Service, and the Postal Service.
Table 2. The 44 foreign animal diseases (FAD) searched for in the Current Research Information System (CRIS)

<table>
<thead>
<tr>
<th>FAD on which research is performed in the U.S.</th>
<th>FAD on which no research is performed in the U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot and mouth disease</td>
<td>Peste des petits ruminants&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>African swine fever</td>
<td>Hog cholera&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Vesicular stomatitis</td>
<td>Akabane&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Swine vesicular disease</td>
<td>Contagious agalactia&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Vesicular exanthema of swine</td>
<td>Contagious bovine pleuropneumonia&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>San Miguel sea lion virus</td>
<td>Contagious caprine pleuropneumonia&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Rinderpest</td>
<td>Equine encephalitis&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Rift Valley fever</td>
<td>Goat pox&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Velogenic viscerotropic</td>
<td>Lumpy skin disease&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Newcastle disease</td>
<td>Teschen disease&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>African horsesickness</td>
<td>Borna disease&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fowl plague</td>
<td>Infectious petechial fever&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Bluetongue</td>
<td>Hemorrhagic septicaemia&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Bovine ephemeral fever</td>
<td>Sweating sickness&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Ibaraki</td>
<td>Louping ill&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Malignant catarrhal fever</td>
<td>Melioidosis&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Trypanosoma brucei and T. congoleuse</td>
<td>Wesselsbron disease&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Trypanosoma vivax</td>
<td>Porcine babesiosis&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Egg drop syndrome '76&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Nairobi sheep disease&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Bovine babesiosis</td>
<td>Dourine</td>
</tr>
<tr>
<td>Contagious equine metritis</td>
<td>Glanders</td>
</tr>
<tr>
<td>Heartwater&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Theileria-East coast fever&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Research has been conducted on these diseases in previous years.

<sup>b</sup> Diagnostic competence is not available for these diseases.

<sup>c</sup> No longer considered a FAD.

<sup>d</sup> Since fiscal year (FY 1981), research has commenced on heartwater and diagnostic competence has been developed.

<sup>e</sup> Work on Nairobi sheep disease was never started even though it was listed in CRIS.
<table>
<thead>
<tr>
<th>Disease</th>
<th>ARS Direct Funds</th>
<th>ARS Indirect SY</th>
<th>SAES Direct Funds</th>
<th>SAES Indirect SY</th>
<th>Total Funds</th>
<th>SY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot &amp; mouth dis</td>
<td>5,611</td>
<td>14.5</td>
<td>0</td>
<td>0</td>
<td>5,616</td>
<td>14.5</td>
</tr>
<tr>
<td>Afr swine fever</td>
<td>3,114</td>
<td>8.1</td>
<td>123 l/ .5</td>
<td>16 c/ .1</td>
<td>3,253</td>
<td>8.7</td>
</tr>
<tr>
<td>Bluetongue</td>
<td>1,683 8.4</td>
<td></td>
<td>0</td>
<td>1,313 9.1</td>
<td>3,119</td>
<td>18.2</td>
</tr>
<tr>
<td>W/V Newcastle</td>
<td>508 3.1</td>
<td>60 .4</td>
<td>142 .2</td>
<td>897 4.2</td>
<td>1,606</td>
<td>7.9</td>
</tr>
<tr>
<td>Bov babesiosis</td>
<td>2,688 1.5</td>
<td>0</td>
<td>193 d/ 1.1</td>
<td>0</td>
<td>461</td>
<td>2.6</td>
</tr>
<tr>
<td>Nairobi sheep dis</td>
<td>279 e/ .9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>279</td>
<td>0.9</td>
</tr>
<tr>
<td>Cont equine met</td>
<td>0</td>
<td>0</td>
<td>71 f/ .6</td>
<td>201 g/ 1.4</td>
<td>272</td>
<td>2.0</td>
</tr>
<tr>
<td>Theileria-ECF</td>
<td>217 1.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>217</td>
<td>1.0</td>
</tr>
<tr>
<td>Trypan vivax</td>
<td>140 .4</td>
<td>0</td>
<td>68 h/ 1.0</td>
<td>207 1.4</td>
<td>60.4</td>
<td></td>
</tr>
<tr>
<td>Fowl plague</td>
<td>50 f/ .3</td>
<td>0</td>
<td>5 j/ 0.0</td>
<td>107 .4</td>
<td>161</td>
<td>0.7</td>
</tr>
<tr>
<td>Trypan brucei</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
</tr>
<tr>
<td>Rift Valley fev</td>
<td>105 .4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>134</td>
<td>0.5</td>
</tr>
<tr>
<td>Ves exanthema</td>
<td>81 .2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>81</td>
<td>0.2</td>
</tr>
<tr>
<td>Ves stomatitis</td>
<td>0</td>
<td>0</td>
<td>54 m/ .1</td>
<td>11 n/ .1</td>
<td>65</td>
<td>0.2</td>
</tr>
<tr>
<td>Sea lion virus</td>
<td>56 .2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>56</td>
<td>0.2</td>
</tr>
<tr>
<td>Rinderpest</td>
<td>56 .2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>56</td>
<td>0.2</td>
</tr>
<tr>
<td>Egg drop syn</td>
<td>0</td>
<td>0</td>
<td>39 .3</td>
<td>0</td>
<td>39</td>
<td>0.3</td>
</tr>
<tr>
<td>Malig catar fev</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>28 .4</td>
<td>28</td>
<td>0.4</td>
</tr>
<tr>
<td>Rov ephem fev</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0.0</td>
</tr>
<tr>
<td>Afr horse sick</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0.0</td>
</tr>
<tr>
<td>Swine ves dis</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0.0</td>
</tr>
<tr>
<td>Ibaraki</td>
<td>3</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0.1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>10,626 31.6</td>
<td>1,866 9.3</td>
<td>533 2.4</td>
<td>2,751 17.0</td>
<td>15,773</td>
<td>60.4</td>
</tr>
</tbody>
</table>

Table 3. National summary of foreign animal disease (FAD) research. Fiscal year 1981: Funds ($000) and scientist years by disease.
Footnotes for Table 3

(a) Time analysis in Paraguay - CA

(b) Role of feral swine and ectoparasites (collection in Florida) - NY
Development of immunologic labeling procedures at Hofstra Univ. - NY
Development of cell lines spontaneously susceptible at Purdue - IN

(c) Susceptibility of feral swine (work performed at Plum Island Animal Disease Center, NY) - FL

(d) Blood changes and immunity - TX

(e) This project never got underway even though it was listed in the Current Research Information System. Funds and personnel involved researched other FAD.

(f) Treatment of carrier state - NY

(g) Reproductive pathology of infectious diseases - CO
Computer assisted enzyme-linked immunosorbent assay (ELISA) - NY

(h) System of monitoring immune response to *Trypanosoma*
(T. cervi and T. theileri) - WY
Serodiagnosis and pathogenic potential of T. theileri - IL

(i) Field isolates causing high mortality in the field - GA

(j) Highly pathogenic virus of turkeys - WI

(k) Effect of chemotherapeutics and chemoprophylaxis on T. brucei in bloodstream and cultured forms - CO

(l) Vectors of T. cruzi - NY, TX

(m) Replication (wild type) in cell cultures - KS

(n) Measure of interferon
Ts mutants - AL
KS

(o) Figures may not total exactly due to rounding

Definitions:
ARS = Agricultural Research Service, U.S. Department of Agriculture.
SAES = state agricultural experiment stations.
SY = Scientist years, or the equivalent of one full-time scientist for one year.
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STUDIES ON EXOTIC VESICULOVIRUSES

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SUMMARY

The reported studies on Piry, Chandipura and Isfahan vesiculoviruses which are exotic to the USA indicate low probability that they would cause clinical disease in livestock. Ponies, cattle, swine, sheep and goats were inoculated intradermally or intradermalingually. Only mild lesions occurred at the site of inoculation and no secondary lesions developed. In contrast ponies, cattle and swine inoculated with an isolate from the 1982–83 outbreak of New Jersey VSV showed much more extensive and classical lesions of vesicular stomatitis. Infectious virus was not recovered from blood collected after inoculation of exotic vesiculoviruses nor from pooled suspensions of liver, spleen and pharyngeal lymph nodes collected at necropsy. These exotic viruses were highly pathogenic for suckling mice and hamsters but not for adult mice, hamsters, guinea pigs or rabbits with the exception of Piry virus which did kill some adult hamsters. All animals inoculated developed specific virus neutralizing antibody. Low levels (50% endpoint less than 1:8) of virus neutralizing antibody were found in native US cattle and swine sera using Indiana 2, Indiana 3, Piry and Chandipura viruses but not Isfahan. This antibody activity was considered to be non-specific and its prevalence ranged from 5 to 89%.

These studies were important to augment differential diagnostic procedures for vesicular diseases and to put in perspective the possible pathogenic potential of numerous vesiculoviruses being isolated throughout the world.

INTRODUCTION

Vesicular stomatitis (VS) is a disease of horses, swine and cattle which has been recognized for over 100 years. The causative viruses are classified in the genus Vesiculovirus of the family Rhabdoviridae, and serotypes New Jersey and Indiana are responsible for the classical disease. Vesicular stomatitis is restricted to the Western Hemisphere. It was introduced into France and South Africa following introduction of animals from the USA but the disease disappeared spontaneously and has not been reintroduced.

The natural susceptibility of livestock to vesicular disease is reviewed in Table 1. Vesicular stomatitis has been observed naturally in horses, cattle, and swine, but is equivocal and probably not a natural occurrence in sheep, goats and deer. The classification of viral agents causing vesi-

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cular diseases is shown in Table 2.

The purpose of the studies reported here was to determine the susceptibility of domestic livestock to three exotic vesiculoviruses (serotypes Piry, Chandipura and Isfahan). In addition, their pathogenicity and immunogenicity was compared to a recent isolate of New Jersey vesicular stomatitis virus (VSV) isolated from the 1982–83 outbreak in the western USA. These studies were needed because no information on the virulence of these three exotic viruses for livestock was available. In addition, US cattle and swine sera showed what was classified as non-specific neutralization of VSV Indiana 2 and 3 serotypes which are exotic to the USA but occur in South America. Anticipated shipments of cattle from India and additional shipments from Brazil where these exotic VSV's occur were the motivating force of these studies.

MATERIALS AND METHODS

Viruses

The following lyophilized vesiculoviruses were received from Dr. Robert Shope, Yale University, New Haven, Connecticut: Piry virus, five suckling mouse brain (SMB) passages; Chandipura virus, two SMB and Isfahan virus four SMB passages. The brain material was reconstituted with sterile water and each virus was passaged once in Vero cell line (obtained from the American Type Culture Collection, Rockville, MD). Each serotype produced complete cytopathogenic effect. A stock of 10% (W/V) SMB was prepared and used for animal inoculation studies. The titers per ml of the 10% mouse brain suspension were \(10^{9.9}\) mouse lethal dose 50% for Piry virus, \(10^{11.9}\) for Chandipura virus and \(10^{9.1}\) for Isfahan virus.

New Jersey VS viral antigen was identified by complement fixation in bovine vesicular epithelium received at the Plum Island Animal Disease Center (PIADC) from Colorado in 1982 (R. J. Yedloutschnig, PIADC, Unpublished data). It was isolated and passaged three times in SMB and once in Vero cell line before a final SMB passage from which a 10% stock was prepared.

Indiana VSV subtypes 2 and 3 were originally received from the Pan American Foot-and-mouth Disease Center in Rio de Janeiro, Brazil. Table 3 summarizes the species from which the original isolation of each virus was made.

Animals

Calves of mixed breeds between 180 and 550 lbs, ponies of mixed breed 1 to 10 years of age, young adult sheep (1 to 4 years of age), goats of mixed breeds and Yorkshire swine (60 to 120 pounds) were obtained locally. Rockefeller H/Plum Island strain mice were produced at the PIADC. New Zealand white rabbits (3 to 5 lbs) and guinea pigs (400 to 450 gm) were obtained from Dutchland Farms, Denver, Pennsylvania 17517. Syrian hamsters were obtained from Charles River Laboratories, Wilmington, Massachusetts 01887.
Biocontainment

All work was conducted in the Foreign Animal Disease Diagnostic Laboratory at the PIADC which is rated at least a biocontainment level III. Individual battery operated respirators supplying high efficiency particulate air (HEPA) filtered through a hood covering the head and shoulders were used while handling of inoculated animals (Vickers American Medical Corp., Whitehouse Station, New Jersey 08889). Class II vertical laminar flow biocontainment hoods were used for in vitro work. (Baker Co., Inc., Sanford, Maine, USA 04073 and Nu Aire, Plymouth, MN USA 55441).

EXPERIMENTAL DESIGN

Pathogenicity for livestock

One ml of each virus was inoculated into each of 2 ponies, 2 steers, 3 sheep, 3 goats and 3 pigs intradermalingually or, in the case of the pigs, intradermally in the snout, heel and coronary band. New Jersey VSV was not inoculated into sheep and goats. Inoculated animals were housed in a biocontainment room with an equal number of uninoculated contact animals of each species. Blood for serum was collected at weekly intervals. The animals were examined daily and heparinized blood was collected daily for 4 days after inoculation and weekly thereafter until termination of the experiment. At necropsy separate samples of liver, spleen and a pharyngeal lymph node were collected from inoculated animals. The experiment with Piry was terminated 4 weeks after inoculation. For Chandipura and Isfahan viruses the sheep, goats and swine were terminated 2 weeks after inoculation and ponies and calves 4 weeks after inoculation.

Backpassage of Piry virus in cattle and ponies

Two days after two ponies were inoculated with Piry virus, affected tongue epithelium was collected and a 10% suspension prepared in minimum essential medium. One ml of the 10% suspension was inoculated intradermalingually into each of 2 ponies and 2 calves which were seronegative to Piry virus.

Pathogenicity for laboratory animals

Day-old mice were inoculated intracranially (IC) and intraperitoneally (IP), adult mice IP and subcutaneously (SC), day-old hamsters IC and IP, adult hamsters IP and SC, adult guinea pig intradermally (ID) and IP and adult rabbits intravenously (IV) with each virus. Volumes used for inoculation were 0.03 ml IC, and 0.1 ml IP, ID and SC. Animals were observed 2 to 4 weeks following inoculation.

Normal swine and cattle sera

Sera were collected from native US cattle (Iowa, Minnesota and Virginia) and swine (Georgia and New York). They were held at -20°C until
heat inactivated at 56° for 30 minutes and used in a microtiter neutralization test against approximately 100 TCID<sub>50</sub> of each of the 5 vesiculoviruses.

RESULTS

Pathogenicity of viruses for various animals is summarized in Table 4. Ponies inoculated with New Jersey VSV showed comparatively the most extensive lesions including vesicle formation and rupture within 24 hours; one of the two ponies exhibited an elevated temperature (2°C) 1 day post inoculation (DPI). By 3 DPI the majority of tongue epithelium from both animals sloughed. Piry virus caused a 2 and 3°C temperature elevation 1 DPI in the two inoculated ponies but the lesions were substantially less severe than with New Jersey VSV; a slight extension of the lesion up to 3 cm from the inoculation site occurred. Chandipura and Isfahan viruses caused neither extension from the lesion at the site of inoculation to surrounding tissue nor a fever.

New Jersey VSV caused a 1 and 2 day fever of 1 to 2°C in the two inoculated cattle. Lesions consisted of epithelial blanching that lasted up to 3 DPI in one animal and blanching followed by erosion in the second animal by 3 DPI. Chandipura virus caused blanching and a shallow ulcer in 1 of the 2 steers 3 to 4 DPI; the lesion healed by 7 DPI. Inoculation of Piry and Isfahan viruses did not affect cattle.

Two of three swine inoculated with New Jersey VSV showed small vesicles at 1 DPI which progressed to large ones on the snout by 3 DPI. Tongue erosions occurred and one secondary lesion under the tongue developed in one pig. A second pig exhibited a 1°C fever on 1 and 3 DPI. None of the exotic VSV's caused clinical signs in swine.

Only the exotic viruses were inoculated into sheep and goats. Clinical signs were limited to one goat that developed a small blanched area at the site of injection of Chandipura virus.

None of the exotic VS viruses caused secondary lesions in inoculated animals. None of the contact animals in any groups developed clinical signs of vesiculovirus infection.

Infectious virus was not recovered from blood samples collected from any animals inoculated with the exotic viruses. Likewise, virus was not recovered from pooled suspensions of liver, spleen and pharyngeal lymph nodes collected at necropsy from inoculated animals at termination of the study.

None of the contact animals in any groups developed clinical signs of vesiculovirus infection.

Low levels of virus neutralizing antibody were found in the pre-inoculation sera of some subject animals with Piry virus (5/6 swine) and Chandipura virus (1/4 horses, 4/4 cattle, 6/6 swine, 1/6 goats and 1/6 sheep). This antibody was considered to be non-specific and fifty percent neutralization endpoints were less than 1:8. All animals inoculated with the three exotic viruses developed serotype specific neutralizing antibody by the termination of the experiment. No contact animals developed
low titers (generally less than 1:8), the lack of clinical disease, and because the viruses have never been identified in the USA. The use of vesiculovirus glycoprotein for immunoelectroosmophoresis (IEOP) or counterimmuno-electrophoresis was shown. Glycoprotein preparations for use in the complement fixation and enzyme linked immunosorbent assay tests are in progress.

REFERENCES

antibody to Isfahan virus but 1 contact sheep seroconverted to Piry virus and 2 of 2 contact steers and 2 of 2 contact ponies seroconverted to Chandipura virus (Table 5).

A 10% suspension of vesicular epithelium collected from ponies 2 DPI titered $10^{5.2}$ TCID$_{50}$ per ml. When the suspension was inoculated intradermalingually into 2 seronegative ponies and calves, no clinical signs of disease were observed.

Suckling mice and hamsters were highly susceptible to each of the 3 exotic vesiculoviruses. Chandipura virus killed rapidly (within 18 hours) while Isfahan virus required 36 to 72 hours. Piry virus was intermediate in this respect. Brain or liver-spleen suspensions from mice had titers from $10^{7.6}$ to $10^{12.9}$ per gram of tissue; viral infectivity titers of Isfahan tended to range lower while Chandipura was the highest. One of six hamsters inoculated SC with Chandipura virus, two of five adult hamsters inoculated IP with Piry virus, and 3 of 4 nursing mothers of Piry virus inoculated day-old hamsters died.

Neutralizing activity against all exotic viruses except Isfahan was found in the sera of native US cattle and swine. The highest prevalence noted at a final screening dilution of 1:10 occurred against Indiana 3, with cattle and swine respectively showing 50 and 89%; cattle had a 23% prevalence of antibody against Chandipura virus and swine 21% against Indiana 2 virus (see Table 7).

**DISCUSSION**

Results of studies on exotic vesiculovirus serotypes Piry, Chandipura and Isfahan were summarized and compared with livestock inoculated with a current isolate of New Jersey VSV.

All of the exotic viruses caused lesions in ponies but even the most extensive lesions caused by Piry virus were much less severe than those caused by New Jersey VSV. Unlike classical VS, the 3 exotic serotypes did not cause dramatic extension from sites of inoculation. Lesions were not produced by backpassage of Piry virus in ponies and calves indicating a low level of virulence. Clinical signs caused by the three exotic viruses are not likely to be confused with classical VS caused by New Jersey and Indiana serotypes.

The only lesions observed in livestock other than ponies were caused by Chandipura virus in one calf and one goat. There were minimal lesions at the site of inoculation and these would hardly have been confused with a vesicular disease. No lesions occurred in sheep following inoculation with any of the exotic viruses.

Suckling mice and hamsters were highly susceptible to the 3 exotic viruses confirming their utility in laboratory diagnosis of these infections.

The detection of presumably non-specific neutralizing activity in native US cattle and swine against Indiana 2 and 3 as well as Piry and Chandipura viruses confirms the need for sensitive and specific serodiagnostic tests. This neutralizing activity is considered non-specific because of the
TABLE 1. Natural Susceptibility of Livestock and Deer to Vesicular Diseases.

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<th>VS</th>
<th>SVD</th>
<th>VES/SMSV Infection</th>
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<sup>a</sup> FMD = Foot-and-mouth disease.
<sup>b</sup> VS = Vesicular stomatitis.
<sup>b</sup> SVD = Swine vesicular disease.
<sup>b</sup> VES/SMSV Infection = Vesicular exanthema of swine/San Miguel sea lion virus infection.

<sup>b</sup> NT = not tested.
### TABLE 2. Classification of Viral Agents Causing Vesicular Diseases.

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TABLE 4. Summary of Pathogenicity of Vesculoviruses for Livestock.

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<th>Chandipura</th>
<th>Isfahan</th>
<th>New Jersey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponies</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Cattle</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>Swine</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>++</td>
</tr>
<tr>
<td>Sheep</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>ND</td>
</tr>
<tr>
<td>Goat</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>ND</td>
</tr>
</tbody>
</table>

0 = No lesions.
+ = Erosion or swelling at the site of inoculation.
++ = Vesicle development, ulceration and extension of lesion up to 1.0 cm from inoculation site.
+++ = Vesicle development followed by ulceration and extension at least 2 cm from infection site with loss of epithelium.
TABLE 5. Virus Neutralization Studies on Convalescent Sera From Livestock* Inoculated With Exotic Vesiculoviruses.

<table>
<thead>
<tr>
<th>Species</th>
<th>Piry</th>
<th>Chandipura</th>
<th>Isfahan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponies</td>
<td>I(2)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>C(2)</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Cattle</td>
<td>I(2)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>C(2)</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Swine</td>
<td>I(3)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>C(3)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Goats</td>
<td>I(3)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>C(3)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sheep</td>
<td>I(3)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>C(3)</td>
<td>1/3</td>
<td>-</td>
</tr>
</tbody>
</table>

I = Inoculated; C = Contact; ( ) = number; = no antibody; + = all had antibody; Fraction = number positive/number tested

*All pre sera had 50% endpoint titers < 1:8.
TABLE 6. Pathogenicity of Exotic Vesiculoviruses for Laboratory Animals.

<table>
<thead>
<tr>
<th>Host</th>
<th>Route</th>
<th>Piry</th>
<th>Chandipura</th>
<th>Isfahan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+ 30 HRS</td>
<td>+ 18 HRS</td>
<td>+ 36-48 HRS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>+ 30 HRS</td>
<td>+ 18 HRS</td>
<td>+ 48-72 HRS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>+ 24 HRS</td>
<td>+ 18 HRS</td>
<td>+ 48 HRS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>+ 4,10 DAYS(2/5)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>+ 3 DAYS(1/6)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>+ 3, 4 DAYS(3/4)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>+ (1/4)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* a = IC = intracranially; + = death; - = no death, no lesions;
* IP = intraperitoneally; SC = subcutaneously; CON = contact; ID = intradermally in footpad; IV = intravenously.
TABLE 7. Results of Virus Neutralization Tests on Sera of Native US Cattle and Swine.

<table>
<thead>
<tr>
<th>Virus</th>
<th>Cattle</th>
<th>Swine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indiana 2</td>
<td>8/120&lt;sup&gt;b(7)c&lt;/sup&gt;</td>
<td>16/78 (21)</td>
</tr>
<tr>
<td>Indiana 3</td>
<td>60/120 (50)</td>
<td>69/78 (89)</td>
</tr>
<tr>
<td>Piry</td>
<td>4/120 (3)</td>
<td>5/78 (6)</td>
</tr>
<tr>
<td>Chandipura</td>
<td>14/60 (23)</td>
<td>3/60 (5)</td>
</tr>
<tr>
<td>Isfahan</td>
<td>0/60 (0)</td>
<td>0/60 (0)</td>
</tr>
</tbody>
</table>

<sup>a</sup> = Final serum dilution 1:10 against approximately 100 TCID<sub>50</sub> of virus.

<sup>b</sup> = Number showing neutralization/number tested.

<sup>c</sup> = (%) = % showing neutralization.
GLOBAL STATUS OF ANIMAL DISEASES EXOTIC TO THE UNITED STATES, NOVEMBER 1983.

by Dr. H. J. Seyffert, International Operations and Screwworm Staff

Since this topic was addressed a year ago, the global animal disease situation has remained somewhat static, without major changes, either for worse or for better. Some events have again shown the advantage enjoyed by countries with developed strategies and resources to rapidly deal with exotic disease outbreaks. Thus some potentially big problems were quickly eliminated. (Denmark, Italy). On the other hand, some problems in lesser developed countries remain as unsolved as they were a year ago. Details can be listed as follows:

FOOT-AND-MOUTH DISEASE (FMD)

After a few cases early in the year, which can be considered residues from the previous year, the situation in Europe was stable. There was only one more case in Denmark, type O1, in January 1983. East Germany had a few more cases late in 1982. Type A, seen in Spain and Portugal in January and February, was still in Portugal in May 1983. It was quiet from then on except in Turkey where type O1 and A22 was last reported in May and very likely did not stop then. Type O1 was reported as late as March 1983 from the USSR but not from areas close to other European countries.

In Africa, the disease appeared in almost all areas. It was reported from Egypt, South Africa (SAT2), Zimbabwe (SAT3), Mozambique, Morocco (A5), Kenya, Libya (O), Somalia (O), Tanzania, Ivory Coast, Malawi, Nigeria (SAT2), Zambia (O), Uganda, Sudan (A), Tunisia, Senegal (SAT2). Type SAT2 in Nigeria and Senegal may be considered somewhat unusual, as this type is generally seen in the southern part of the continent.

The situation in Asia is similar to the one in Africa; the disease shows up just about everywhere. Reports came from Iran (O), Iraq, Kuwait (O), Pakistan (O), India (O, A, C, and Asia1), Burma (O and Asia1), Thailand, Saudi Arabia (O), Butan (A), Hong Kong, Yemen (O), United Arab Emirate (O), Malaysia (O), Oman (O), and Indonesia (O).

In the Americas, the disease was reported from Argentina, Brazil (O, A, C); Colombia (O, A), Peru (C1, O1, A1), Paraguay, Uruguay, Venezuela (O, A), Bolivia (A, C), Ecuador (A). During the year, Chile obtained recognition by USDA as being free from FMD. This may show other countries in the area that freedom from FMD is indeed an attainable goal.

Remark: Virus types, if not listed, were not available.

RINDERPEST

Attempts to halt the spread of this disease throughout Africa are still fragmentary and consist of local efforts. No financing and support for regional efforts could be put together. So far the disease was reported from Kuwait, Oman, Egypt, Lebanon, Syria, Israel, Niger, Tanzania, Mali, Chad, Cameroon, and Nigeria.
CONTAGIOUS BOVINE PLEUROPNEUMONIA

Most of the reports on this disease again came from Africa. It was seen in Angola, Ivory Coast, Mali, Niger, Ghana, Namibia, and Kenya. In Europe, no more cases were found in southern France, but surveillance is continuing. By March 1983, some 82 cases were found in Portugal. No reports came from Spain, but it is hard to believe that there are no connections between the cases in France and Portugal and that Spain is not involved.

LUMPY SKIN DISEASE

This disease was reported from Kenya, South Africa, Zambia, Madagascar, and Malawi.

AFRICAN HORSESICKNESS

This disease was only reported from South Africa, Namibia, and Zambia. These are all sporadic cases, without epidemic proportions.

DOURINE

Dourine is consistently being reported from South Africa, Namibia, and Italy.

GLANDERS

Glanders is most consistently reported from Turkey, but case numbers are going down. Otherwise it is occasionally seen in South Africa and Namibia. It was also seen in Mauritania.

AFRICAN SWINE FEVER (ASF)

This disease now appears to have been eradicated from the Western Hemisphere. Final efforts are underway to officially declare Haiti and the Dominican Republic free of the disease. Such a declaration is also expected soon from Brazil. In Europe, it was possible to prevent disease spread from an outbreak on the mainland of Italy. Otherwise, however, the disease remains on Sardinia, in Spain, and in Portugal. From Africa, the disease was reported in Angola, Malawi, Mozambique, and Zambia. It probably still exists in other locations on that continent, like Cameroon.

HOG CHOLERA

This disease is still being reported from almost all swine-producing areas of the world. However, especially in Europe, efforts are being increased to eliminate the disease by destroying infected herds instead of just relying on vaccination to stop spread.

SWINE VESICULAR DISEASE

Incidence of this disease appears to have gone down, especially in Great Britain. Otherwise cases were reported from France and Italy. Serological evidence of the disease was reported from Hungary in swine recently imported from Sweden. This led to intensive investigations in Sweden, but
the disease could *not* be confirmed to be present there and a declaration to that effect was issued.

**SHEEP AND GOAT POX**

A case of this disease was reported from Italy, a country where the condition had not been seen for a long time. The origin was not fully determined but was probably North Africa. No spread occurred. Otherwise, the disease was reported from Turkey, Tunisia, Algeria, Morocco, Mauritania, Iran, Kuwait, Iraq, Israel, and Egypt.
REPORT OF THE COMMITTEE ON FOREIGN ANIMAL DISEASES

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Vice Chairman: J. L. Hyde, Beltsville, MD

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The Committee on Foreign Animal Diseases met on October 18 and 19, 1983 during the 87th Annual Meeting held at the Sahara Las Vegas Hotel, Las Vegas, Nevada. Eighteen members and twenty-five guests were present at the meetings.

The first meeting was devoted to the revision of the Foreign Animal Diseases book to be published by the U.S. Animal Health Association in 1984. A prospective list of authors, internationally renowned in their respective areas of expertise, was selected by a specially designated sub-committee to re-write the various disease entities to be covered. Additionally, a reviewer was chosen for each of the primary authors. Letters were prepared for each of the authors, requesting their collaboration in this important task. Emphasis was placed on the time constraints and the Committee's firm commitment to produce the book in time for distribution by October, 1984, the time of the next USAHA meeting in Fort Worth, Texas. It is intended to design an appropriate cover for the book to commemorate the 100th anniversary of the founding of the Bureau of Animal Industries, the progenitor of the several agencies of the Department of Agriculture concerned with animal health in the United States.

The second meeting of the FAD Committee was highlighted by the presentation of four reports and three scientific papers, two of the latter having also been presented to the general membership.

Dr. W.R. Heron gave a brief presentation to inform the Committee of the reported existence of hog cholera along the California-Mexico border.

An outbreak of anaplasmosis in Canada was described by Dr. I. Ross Reid of the Canadian National Veterinary Services.

Activities of the Emergency Programs Staff of the National Emergency Field Operations during 1983 was given in detail by Dr. W.W. Buisch. His
report describing disease investigative studies, virus isolations, and arthropod vector surveys is given below.

EMERGENCY PROGRAMS
PROGRESS REPORTS

During fiscal year 1983, October 1, 1982—September 30, 1983, there were 282 investigations in the United States for foreign animal diseases. The vesicular stomatitis (VS) outbreak that started in June of 1982 continued in cattle and horses west of the Mississippi River until May 25, 1983. Statistically, over 1,324 premises were investigated with laboratory confirmation of positive results on 615 of these premises in 15 States. Of this total, over 700 cases were investigated in fiscal year 1983, with a resulting positive diagnosis on 237 of the premises. Although historically vesicular stomatitis usually disappears during the winter months when insect vectors are no longer prevalent, it was noted during this recent outbreak that positive cases continued to occur regardless of the time of year. In fact, contact spread seemed to play a significant role in disease spread. More recently, serological results indicate VS activity in two horses in Colorado and Wyoming in September 1983.

Two virus isolations from wild swine on Ossabaw Island (off the coast of Georgia) occurred in July 1983. This area may be an enzootic area and is not related to the 1982–83 outbreak.

The initial velogenic viscerotropic Newcastle disease (VVND) case for fiscal year 1983 was found on March 25, 1983. As in the past, smuggled Amazon parrots were implicated as the source of the introduction. The sale of immature yellow-naped Amazon parrots were the source of 11 positive VVND cases in California. Sales from California resulted in the following positive cases: Nevada (2), Kentucky (1), New York (1), and Florida (1). In addition, 8 cases were diagnosed VVND positive in fighting game birds in Laredo and Los Morenos, Texas. Again, illegal movements of fighting cocks from Mexico were considered to be the mode of introduction.

During July 1983, a second survey for the fly, Musca vitripennis, was conducted at the McGuire Air Force Base, New Jersey. Since no further findings were noted, it was decided that the fly had not become established in this area. The ability of this fly to carry the nematode Parafilaria boucicola is well recognized, and therefore, we have urged that vigilance be maintained at our ports of entry in intercepting possible further introductions of this pest.

A single louse fly, H. longipennis, was captured on a bat-eared fox recently imported from South Africa, at the North Carolina Zoological Park, Asheboro, North Carolina, May 16, 1983.

The presence of Amblyomma variegatum ticks was confirmed in Puerto Rico in June 1974, the presence of Boophilus microplus was confirmed in January 1978. On August 19, 1983, a single nonengorged female Amblyomma cajennense, a 3 host tick, was collected in a herd that was
being treated for boophilus infestation. Inspection of all animals on the premises and adjacent premises failed to disclose any further *Amblyomma cajennense* ticks. Their origin and incidence elsewhere on the island are unknown.

One Foreign Animal Disease Diagnosticians Course was conducted during this fiscal year. Therefore, with the addition of 15 newly trained diagnosticians, we now have available in the United States a total of 255 veterinarians trained in the differential diagnosis of foreign animal diseases.

Foreign Animal Diseases Awareness Seminars were held at veterinary colleges in the States of Virginia, Michigan, and Massachusetts. A Foreign Animal Disease Seminar for Diagnosticians was held at the National Veterinary Services Laboratories, Ames, Iowa. In addition, a course and a seminar on “Military Support for Emergency Animal Disease Programs” were given.

The five Regional Emergency Animal Disease Eradication Organizations (READEO’s) are fully staffed and maintained to respond rapidly to outbreaks of emergency diseases.

A test exercise involving the Northern and North Central Regions of Veterinary Services was held to test our preparedness to respond to an emergency outbreak situation. “RIEN”—a code name for African swine fever—was used for the exercise in question. The affected industries were closely involved, with farmers belonging to the American Farm Bureau Organization actively taking part in the scenario and responding to the questions posed by the READEO teams. In addition, systems of improving communication within the READEO organization, and information to the public at large, were implemented.

The State of Virginia held a test exercise simulating an introduction of Rift Valley fever. The scenario centered on the initial process of diagnosis and response so critical to the effective eradication of such disease entities. The coordination of the State, Federal, and industry team approach, including the READEO organization, proved most effective.

A meeting of the Secretary’s Foreign Animal Disease Advisory Committee was held in the Emergency Programs Information Center, Hyattsville, Maryland, in October 1982.

In addition, the laboratory coordinators, representing diagnostic laboratories throughout the United States, met to discuss their role during an emergency foreign animal disease outbreak. As a result of this meeting, the laboratory section of the READEO organization has been moved to a position directly under the Director of the READEO team. This should provide the laboratory section with more visibility, thereby assuring that the laboratory competency, so important during an exotic disease outbreak, is fully supported.

Acute Equine Diarrhea Syndrome (Potomac Fever) continues in the States of Maryland and Virginia. State, Federal, and university officials
are still plagued with the question of the cause.

A meeting of the North American Foot-and-Mouth Disease (FMD) Vaccine Bank was held in Mexico City, Mexico. Member countries in attendance included Canada, Mexico, and the United States. Discussions centered on specifications of production, as well as future production needs. It was noted that this is the first regional FMD vaccine bank in the world and may serve as a model for additional regional banks that may be organized in the future.

Several premises in Lancaster County, Pennsylvania, reported losses due to avian influenza. This included premises involving both broilers and layers. The isolated strain of the avian influenza virus was not pathogenic to chickens in the laboratory.

The Department of Defense met with Veterinary Services Regional Directors and, again, reaffirmed their support in providing military support during an outbreak of a foreign animal disease.

Bluetongue, serotype 2, was diagnosed in a cattle herd in Florida. This serotype is not previously known to exist in this country and was discovered in a herd study conducted by Drs. E. P. J. Gibbs and L. S. Greiner, University of Florida. This was a cooperative effort of the University, USDA, and the Florida Department of Agriculture. Serological evidence of the virus was detected, and samples submitted to the Tropical Disease Laboratory, Pirbright, England. The virus was isolated at the Denver Laboratory of USDA's Agricultural Research Service and confirmed as serotype 2 at the Plus Island Animal Disease Center, Orient Point, New York.

On January 13, 1983, foot-and-mouth disease (FMD) was again confirmed in Denmark. The last previous case was reported on May 4, 1982. Indications at that time were that the eradication effort was successful. Two Animal and Plant Health Inspection Service veterinarians, Drs. Keith Hand and Michael Gilsdorf, departed for Denmark to study this particular outbreak. On February 3, 1983, they returned and commented on the intensive epidemiological investigation being undertaken by the Danish authorities. This outbreak further strengthens our policy of waiting 1 year following the last positive case of FMD before a country is recognized as free.

A study on the interaction of Newcastle disease on psittacine birds and domestic poultry was undertaken in the Philippines in cooperation with their Ministry of Agriculture and the USDA, Office of International Cooperation and Development. The United States participants included Dr. D. C. Johnson, APHIS, and Dr. C. E. Couvillion, Southeastern Cooperative Wildlife Disease Study. Such exchanges are important in providing for the exchange of scientific and technical information, as well as providing a basis for future development of animal health worldwide.

The Foreign Animal Disease Report continues to be published on a quarterly basis, providing information on recent developments relative to
REPORT OF THE COMMITTEE

foreign animal diseases. This includes noted movements and changes in the characteristics of the diseases of concern.

An animal disease surveillance system is being developed in coordination with the USAHA Morbidity and Mortality Committee. Recently, programs were initiated in the States of Ohio and Tennessee. It is hoped that with statistically-sound information we will be better able to monitor the health of our livestock populations nationwide.

Both the African Swine Fever Eradication Guide and the Diagnostic Guide were developed by the Technical Support Staff of Emergency Programs, APHIS. Also, in cooperation with the Agricultural Research Service, a new list of foreign animal diseases of concern was developed and prioritized.

In addition, in order to support the Recorded Emergency Animal Disease Information System, advanced training was provided to several of the computer operators.

A Foreign Animal Disease Conference put on by the State of California was held at the University of California, Davis, California. Documents reviewing the history of vesicular stomatitis, as well as the economic consequences of vesicular stomatitis in Colorado, were prepared by Drs. R. E. Yoxheimer and F. J. Alderink, respectively. Also, the READEO Organizational booklet was revised.

The Technical Support Staff of Emergency Programs continues to support the Cooperative Agreements with the University of Wisconsin and the Southeastern Cooperative Wildlife Disease Study, Athens, Georgia. This includes refinement of the techniques in the diagnosis of VVND and defining the role that wildlife will play in outbreaks of foreign animal diseases. The data bank now has approximately 49,000 articles on foreign animal diseases, covering 26 diseases and entomological items.

Memorandums of understanding were completed with all 50 State Fish and Wildlife Agencies nationwide. This will greatly facilitate their support during an emergency outbreak.

The depopulation of domestic swine phase of the African swine fever campaign in Haiti was completed June 15, 1983. This was the last foothold of African swine fever in the Caribbean. All that remains are approximately 30 head of feral swine. With the assistance of the Southeastern Cooperative Wildlife Disease Study, it is hoped that this phase will soon be completed.

SUMMARY OF OTHER COMMITTEE REPORTS

The reported studies on Piry, Chandipura and Isfahan vesiculoviruses which are exotic to the USA indicate low probability that they would cause clinical disease in livestock. Ponies, cattle, swine, sheep and goats were inoculated intradermally or intradermalingually. Only mild lesions occurred at the site of inoculation and no secondary lesions developed. In contrast ponies, cattle and swine inoculated with an isolate from the 1982–83 outbreak of New Jersey VSV showed much more extensive and
classical lesions of vesicular stomatitis. Infectious virus was not recovered from blood collected after inoculation of exotic vesiculoviruses nor from pooled suspensions of liver, spleen and pharyngeal lymph nodes collected at necropsy. These exotic viruses were highly pathogenic for suckling mice and hamsters but not for adult mice, hamsters, guinea pigs or rabbits with the exception of Piry virus which did kill some adult hamsters. All animals inoculated developed specific virus neutralizing antibody. Low levels (50% endpoint less than 1:8) of virus neutralizing antibody were found in native US cattle and swine sera using Indiana 2, Indiana 3, Piry and Chandipura viruses but not Isfahan. This antibody activity was considered to be non-specific and its prevalence ranged from 5 to 89%.

These studies were important to augment differential diagnostic procedures for vesicular diseases and to put in perspective the possible pathogenic potential of numerous vesiculoviruses being isolated throughout the world.7

Dr. Floyd M. Jones presented an illustrated narrative of U.S. Department of Agriculture foreign animal disease activities in Panama. Dr. Jones' annual discussions have kept this committee well informed of field and diagnostic studies in Central America.

Two scientific papers were presented to the general assembly by members of this Committee. Dr. H. Graham Purchase discussed "Research on Foreign Animal Diseases in the United States." Dr. James A. House prepared an interesting, illustrated, and informative paper on "Studies of Exotic Vesicular Viruses." These, plus a detailed report by Dr. P.D. McKercher on "Research of Vesicular Diseases," will be incorporated into this Committee's amplified report to be published in the 1983 Proceedings of the 87th Meeting of USAHA. A report of the global status of animal diseases exotic to this country follows.

GLOBAL STATUS OF ANIMAL DISEASES
EXOTIC TO THE UNITED STATES

Foot and Mouth Disease (FMD)

This disease recurred in Denmark in January of this year, following an 8-month interval during which there was no reported FMD. This outbreak of FMD in Denmark seems to justify the U.S. policy of not considering a country free of the disease until that country has remained FMD-negative for a year.

In South America all countries, except Chile and the Guianas, reported outbreaks of FMD. The experience in Chile, the first South American country to become free of FMD, demonstrates graphically the magnificent results of concerted cooperation, dedication, and determination between industry and governmental agencies.
**African Swine Fever (ASF)**

During 1983 restocking of swine in the Dominican Republic has continued to progress satisfactorily.

In Haiti all domesticated swine have been slaughtered and determined efforts are being made to locate and depopulate isolated vestiges of feral swine. Sentinel swine introduced into Haiti have thus far remained free of ASF.

Brazil has reported that ASF has been eradicated from the three largest swine-producing states located in the southern portion of the country.

Determined efforts to eradicate the disease will now be diverted toward the rest of the country.

During this year, there was spread of ASF from Sardinia to two premises in the northern part of the Italian mainland.

**Rinderpest**

Rinderpest reached epidemic proportions in several countries in Africa. This disease was also reported in several countries in the Middle and Far East.

*Contagious Bovine Pleuropneumonia* (CBPP)

Significant outbreaks of this disease were reported this year in Spain and Portugal. Control has been attempted by testing and slaughter methods.

On October 1 of this year, the responsibilities at the Plum Island Animal Disease Center for the diagnosis and training in the recognition of foreign animal diseases were transferred from the Agricultural Research Service to the Animal and Health Inspection Service.

**RESEARCH ON VESICULAR DISEASES**

Research on vesicular viral diseases reviewed in this report consists of studies on foot-and-mouth disease (FMD), swine vesicular disease (SVD), vesicular exanthema of swine (VES) and vesicular stomatitis (VS). This is a review of selected reports considered pertinent to the specific diseases.

**Foot-and-Mouth Disease Virus (FMDV):**

Since the last meeting at least three reports on recombinant DNA technology for the preparation of subunit vaccines have been published (1,2,3). All three of these reports review recent advances in the application of recombinant DNA technology and in the synthesis of nucleotide sequences and their influence on the control and prevention of animal diseases. Henderson (2) relates these advances to FMD and discusses whether these technologies can be used to produce vaccines as good as those currently available. His predictions are optimistic but suggest that
two to three years will be required for development to industrial production.

The PIADC and Genentech staff continue to work together and additional cloning has taken place and plasmids containing the gene for VP, from additional types and subtypes of FMDV have been engineered. Results of an A12 dose response trial in cattle were presented at an FAO meeting in Rome (4). In the group of steers vaccinated with a 10 ug dose, five of nine animals were protected, in the group vaccinated with a 50 ug dose, seven of nine animals were protected. In the two remaining groups vaccinated with a 250 and a 1250 ug dose, eight of nine and nine of nine animals were protected from infection with FMDV, respectively.

Both the 16th Conference of the FMD Commission of the International Office of Epizootics held in Paris, September 1982 and the Session of the Research Group of the Standing Technical Committee of the European Commission for the Control of FMD, United Kingdom, September 1982 dealt mainly with vaccines, some of these reports include relationship between 140S particle content and potency tests in cattle (5), improvements in methods for the assessment of antigens for FMD vaccines which includes a semi-automated method for sucrose density gradient analyses for quantitative assessment of antigens and a proteolytic enzyme assay to predict the integrity of the immunizing protein VP1 (6) and field applications of oil-adjuvanted FMD vaccine in Argentina where the information obtained in the five year study shows a much lower annual outbreak incidence of disease (4.97%) in the oil-vaccine area than in the control area (18.13%) where the animals received AL(OH)3 saponin vaccine (7). Presentations involving rapid identification of FMDV isolates by electrofocussing and by ribonuclease T. fingerprinting are pertinent to diagnosticians (8,9). Electrofocussing is shown to be rapid, can handle large numbers of isolates and is able to discriminate not only between isolates from different outbreaks but also between isolates of the same outbreak. Ribonuclease T. cuts at guanine residues and the resulting mixture of oligonucleotides is separated by electrophoresis in a polyacrylamide gel. Each RNA gives its own distinctive pattern, thus viruses belonging to different serotypes and even to subtypes of the same serotype give very distinct fingerprints. Both of these methods are useful additions to the traditional serological methods. Barteling (10) discusses safety control of FMD vaccines and demonstrated that the intradermalingual inoculation is more sensitive than BHK monolayers and suggests that the sensitivity for every vaccine virus strain, the in vitro safety test system used, has to be compared to the sensitivity of the cattle tongue. The author further found that inactivation of polyethylene glycol (PEG) concentrated virus showed “tailing-off”, was not a first order reaction, and therefore should not be used in vaccine production.

The first description of monoclonal antibodies specific for FMDV (11) states that it is possible to distinguish similar and unique antigenic sites on complete (146S) or (12S) virus particles. These workers also state that some of these monoclonal antibodies can distinguish between 12S subunits.
made by acid degradation of 146S virus (12S\textsuperscript{A}) and those viral components found in infected cell lysates which sediment in sucrose density gradients as "12S subunits" (12S\textsuperscript{N}).

The possible mechanisms for protective roles of milk components on FMDV present in the milk of infected cows were examined (12). Live virus was detected in whole milk and in reconstituted pelleted debris after high temperature short time pasteurization at 72°C for 15 seconds.

**Swine Vesicular Disease Virus (SVDV):**

SVD outbreaks are still occurring in United Kingdom after nine years of attempts to eradicate it. These efforts raise the question of how the virus persists and whether it has become endemic in the United Kingdom. The principal means of persistence of SVDV appears to be by movement of and contact with infected pigs, the feeding of untreated infected waste and contact with contaminated vehicles, and other surfaces on which the virus remains. Rapid detection and diagnosis is essential for control of the disease. The possibility of confusing this disease with FMD remains of utmost importance (13).

A quantitative assay of antibody against SVDV using an indirect enzyme-linked immunosorbent assay (ELISA) on whole blood dried onto filter paper or white blotting paper was examined. Testing of this method by comparing eluates of the dried blood, whole blood and serum of each sample showed good correlation. The use of this method, blood samples dried onto filter paper, avoids the use of syringes, vacutainers and collection bottles, avoids bacterial contamination and the need for refrigeration (14).

The counter immunoelectrophoresis test (CIEPT) has been compared with the serum neutralization and double immunodiffusion tests for the diagnosis and serological surveillance of SVD. The test was less sensitive than serum neutralization, but was simple to perform and gave results within two hours (15).

Experiments conducted at the Plum Island Animal Disease Center, U.S.A. and at the Instituto Zooprofilattico, Italy have shown that the long curing process required for prosciutto hams inactivates SVDV (16).

**Vesicular Exanthema of Swine Virus (VESV):**

More recent publications have involved the pathogenesis of VESV and San Miguel sea lion virus (SMSLV) in swine. Either virus when inoculated intradermally into swine, caused vesicles at the sites of inoculations on the snout, coronary band and tongue, and also fever. Virus was recovered from nasal-oral passages for up to five days after infection with either virus. Neutralizing antibodies reached peak titers in seven to ten days. A mild virus-induced encephalitis was seen in pigs infected with VESV and virus was recovered from brain tissue of pigs infected with SMSLV (17).

Of interest is a report on the first isolation of a calicivirus from the
bovine species (18). This agent caused only minimal lesions in two experimentally exposed calves but did establish a persistent infection with virus shedding for forty-five days. Experimentally exposed swine developed clinical vesicular lesions and this agent appeared more pathogenic for swine than for calves.

**Vesicular Stomatitis Virus (VSV):**

A widespread outbreak of VSV which occurred in fourteen western states last summer and fall, has led to the USDA granting conditional licenses for the production of VS vaccines. Such licenses have been granted to the Colorado Serum Co., Denver Colorado and to the Syntex Laboratories, Des Moines Iowa. These products show promise but are to be used only in states where animal health officials have requested them (19).

Exotic VS types (Indiana-2, Indiana-3, Piry, Chandipura and Isfahan) have been examined at the Plum Island Animal Disease Center. These viruses caused lesions in ponies, the most extensive being caused by Piry, but even these were less severe than those caused by the New Jersey VSV. Serums from U.S. livestock were screened for exotic VS neutralizing titers. Although there were some nonspecific reactions, it was thought that these did not indicate exposure. All sera were considered negative when the complement fixation procedure was used. Glycoproteins can be purified and utilized as an antigen for testing sera for specific antibodies. By the use of the immuno-electroosmophoresis (IEOP) technique and the NJ VS glycoprotein, cross-reaction were eliminated, and the specificity greatly increased (20). The amino acid sequences of glycoproteins from VSV serotypes Indiana and New Jersey respectively have been completed and this should greatly aid in the analysis of the antigenic structure of these molecules (21), as well as allow for synthesis of polypeptides which can be evaluated as immunogens.

**REFERENCES:**

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   **Genentech, Inc., 460 Point San Bruno Blvd., South San Francisco, CA 94080.


EMBRYO TRANSFER AND DISEASE TRANSMISSION IN FARM ANIMALS

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INTRODUCTION

Embryos of farm animals are transferred under commercial conditions during the first few days of their development, when they are surrounded by a relatively thick capsule called the zona pellucida.

Embryos for transfer can be collected non-surgically (cattle, horses), surgically (all species), or possibly at slaughter (all species) following removal of the reproductive tract. Non-surgical collections are carried out on farms, at veterinary clinics, or at embryo transfer centres. Surgical collections are usually done at veterinary clinics or embryo transfer centres, but can be done on the farm. Slaughter collections are normally conducted by slaughtering the animal at an abattoir, removing the reproductive tract aseptically and then flushing the tract under laboratory conditions.

Embryo transfers are carried out either surgically (all species) or non-surgically (cattle, horses). Both procedures can be carried out on farms, at veterinary clinics, or at embryo transfer centres.

The possibility of disease transmission by embryos through embryo transfer is a matter that should be of concern to anyone associated with the embryo transfer industry. It is of particular concern to regulatory veterinarians responsible for controlling the spread of infectious diseases within their country and for preventing the entry of foreign animal diseases into their country.

Diseases of concern from the standpoint of transmission by embryos fall into two categories: infectious and hereditary. In order for zona pellucida-intact embryos to carry or transmit a disease, 1) the cause of the disease has to be present in either the ovum or the spermatozoon, which is the situation in the case of hereditary diseases and could be the case in certain infectious diseases, 2) the causal organism has to penetrate the zona pellucida from the environment (e.g. in the donor) and infect the ovum or embryonic cells, or 3) the causal organism has to infect the recipient either by attaching to the zona pellucida and being transferred with the embryo or by being carried over in the flush fluids; the recipient, in turn, can infect the embryo after it has hatched or developed to a fetus.

Providing that embryos are properly washed or treated prior to transfer, agents of concern in infectious disease transmission from donor and/or sire via embryos are probably viruses rather than bacteria, rickettsia, protozoa or chlamydia. On the other hand, it must be recognized that recipients of embryos should be free of any agents that are capable of being transmitted

*Representing the International Embryo Transfer Society
to the embryo/fetus ‘in utero.’ Evidence based mainly on laboratory animal experiments indicates that there are no guidelines as to which infectious agents can be transmitted from parents to offspring through the gametes or from the environment. Therefore, it is likely that each agent of concern will have to be investigated individually (Eaglesome et al. 1980).

If, as a result of experimental work, it seems likely that certain infectious diseases are not transmitted by embryos, then embryo transfer has the potential to be used as a means of 1) transferring blood lines from a country in which these diseases are endemic to another in which they are not without fear of transmitting them, 2) eradicating these diseases from infected herds or flocks without loss of blood lines, and 3) introducing new blood lines to specific pathogen free (SPF) or otherwise closed herds or flocks without fear of introducing these diseases. Embryo transfer also offers a better program than artificial insemination for upgrading indigenous stock in underdeveloped countries: not only are the effects of upgrading obtained faster, but an imported embryo transferred to the uterus of an indigenous surrogate mother receives immunity to native diseases from that mother at birth (Seidel, 1981).

Research on infectious disease transmission by embryos of farm animals through embryo transfer had received little attention until recently when a few laboratories started to address the problem.

This report endeavours to provide an overview of research completed and in progress, based on published results and personal communications. It also attempts to address the matter of research priorities and concerns in the light of technological developments associated with embryo transfer.

**RESEARCH COMPLETED AND IN PROGRESS**

Work has been reported or is known to be in progress for a number of agents in cattle (Table I), sheep (Table II) and pigs (Table III).

Substantial information on disease transmission by embryos obtained so far from these studies can be summarized as follows:

There is considerable experimental evidence that the bovine leukemia virus (BLV) is not transmitted by zona-pellucida intact bovine embryos that have been washed prior to transfer (Bouillant et al., 1981; Coulthard, 1983 (unpublished); Eaglesome et al., 1982; Hare et al., 1983 (unpublished); Olson et al., 1982, Olson, 1983 (unpublished)) (Table IV). Current research suggests that bluetongue virus (BTV) is likewise not transmitted by zona pellucida-intact bovine embryos (Bowen et al. 1983; Thomas et al., 1983) (Table V). It has also been shown that infectious bovine rhinotraceheitis/infectious pustular vaginitis virus (IBRV/IPV) is not transmitted when zona pellucida-intact bovine embryos are washed and treated with trypsin prior to transfer (Singh et al., 1983) (Table VI). Embryos have been transferred from donors in a pseudorabies infected swine herd to recipients in an SPF herd without any evidence of disease transmission (James et al., 1983) but, on the other hand, it has been shown that zona pellucida-intact porcine embryos exposed ‘in vitro’ to high titres,
10^5 CCID_{50}/ml, of pseudorabies virus and then transferred to recipients resulted in seroconversion in the recipients (Bolin et al., 1982). Also transfer of embryos from donors infected intrauterinely with 25 ml containing 10^5 CCID_{50} PrV to recipients resulted in seroconversion in the latter (Bolin et al., 1982) (Table VII).

One problem associated with this type of research is the generation of sufficient data with which to calculate the probability of disease transmission, recognizing the fact that in biology nothing is absolute. There comes a time when it is no longer cost beneficial to collect further data on an experimental basis and promising results need to be put to a wider test: additional data in the form of increased numbers have to be obtained through field trials. For example, embryos could be transferred out of infected donors in an infected herd/flock into recipients in an uninfected herd/flock, and the recipients monitored for any signs of disease transmission. This type of field trial has already been conducted for pseudorabies in swine (James et al., 1983). Alternatively, embryos could be transferred out of infected donors in an infected herd/flock into clean recipients housed in isolation on the same premises. The recipients would then be monitored throughout gestation and for a period post partum along with the foster progeny. A field trial like this is currently being carried out with a view to eradicating BLV infection from a valuable dairy herd without losing the blood lines (Hare, unpublished data).

Relevant to the international movement of embryos, there are several approaches that could be taken to obtain the numbers that would substantiate or refute experimental data, or allow an estimate of risk to be calculated because situations could arise where the benefits to be gained would be worth the risk involved; obviously the risk involved is affected by the disease involved. For example, for a country free from both enzootic bovine leukosis and foot and mouth disease, the consequences of introducing foot and mouth disease are much more serious than they are for enzootic bovine leukosis.

One approach could be to import donors from an infected area or country to a quarantine station, where superovulation, breeding and collection of embryos would take place. Embryos would then be transferred to recipients isolated from other animals at the quarantine station. The recipients would be closely monitored throughout gestation and post partum with their foster progeny for any evidence of disease transmission. This approach is not very economical from the livestock industry standpoint or the most desirable for disease control, but it does make the logistics of embryo transfer relatively easy.

Another approach could be the collection of embryos from infected donors or donors in an infected area and their importation to a quarantine station, where they would be transferred to uninfected recipients held in isolation from other animals. Recipients and foster progeny would be closely monitored for evidence of disease transmission as before. This approach would be more economical from the livestock industry standpoint and safer for disease control, but the logistics of embryo transfer
would be more difficult, particularly with swine embryos which do not survive cryopreservation and do not tolerate culture and transport as well as bovine embryos, except in the ligated oviduct.

The ideal approach from a disease control standpoint would be to conduct a field trial in quarantine in the country in which the disease, or diseases, of concern is, or are, endemic and then to import the progeny. This approach would not provide any initial economic advantage to the livestock industry over importing the live adult animal, but if the prospect of reduced costs by importing embryos were to be realised, it would prove to be cost beneficial in the long term.

Until substantial information regarding the transmissibility of infectious agents by embryos is available, non-transmission of infectious disease by the embryo will have to be ensured by establishing health requirements for the genetic sire and dam. However, these requirements should be kept flexible to allow for early approval and acceptance of research results and developments as these become available.

What may turn out to be more important to the health of the embryo/fetus than the health of the genetic dam and sire is the health of the recipient. Recipients should have been subjected to veterinary examination and found to be in good health. Recipients should be free from all infectious agents that can be transmitted 'in utero' to the embryo/fetus or post partum to the calf, or can otherwise adversely affect reproduction.

All inseminations of the genetic dam and all embryo collections and transfers should be carried out using strict aseptic procedures. Any serum or trypsin component used in the collection, washing, treatment, culture, freeze-thawing and transport of embryos should be mycoplasma-and virus-free. After embryos have been selected for transfer, it is very important that they be washed thoroughly using a standard procedure. The reasons for this are that research has shown that some agents can be recovered from the uterine flushings of infected animals at the time of embryo collection (Bouillant et al., 1981; Bowen et al., 1983; Singh et al., 1983; Thomas et al., 1983) and, at the moment, different laboratories use different procedures for washing embryos (Bolin et al., 1982; Bowen et al., 1983; Olson et al., 1982; Wrathall and Mengeling, 1979(b). Research at Agriculture Canada has shown that, in order to consistently remove $10^6-10^7$ of virus from embryos, they should be transferred through 10 changes of medium, the pipette used to transfer the embryo should be changed after each of the 10 transfers and each wash should constitute a hundredfold dilution of the previous wash (Singh, unpublished data).

With few exceptions, investigations into infectious disease transmission by embryos have been done using zona pellucida-intact, fresh embryos rather than frozen-thawed embryos, embryos with zonae damaged or removed through filtration or micromanipulation, or hatched embryos. In the course of freeze-thawing embryos, the zona pellucida is damaged (cracked) in a proportion of cases. The damage may run as high as 16% for embryos frozen-thawed in ampoules (Mapletoft, unpublished data), and
higher for those processed in straws (Hagele, unpublished data). The zona pellucida can also be damaged in the process of filtering embryos from flush fluids. When zona pellucida-intact embryos are micromanipulated for sexing or the production of demi-embryos by puncturing the zona with microinstruments, the integrity of the zona as a mechanical barrier to infectious agents in the environment has been destroyed. Therefore, thorough washing of the embryo prior to freezing or micromanipulation would appear to be a prerequisite in order to eliminate the possibility of an infectious agent in the environment gaining access to the embryonic cells. Moreover, in the case of demi-embryo production (Boland et al., 1982, Brem et al., 1983; Lambeth et al., 1983; Ozil et al., 1982; Willadsen, 1979; Willadsen et al., 1981; Williams et al., 1983), where one of the halves is placed in an empty zona, possibly from another animal of the same or even a different species, it is essential to know the health status of the donor(s) of the zona(e) and to ensure that the zona has been thoroughly washed.

Research should also be directed toward finding out if animals that are viremic and animals that are seropositive for antibodies to a particular virus shed virus into the lumen of the oviduct and uterus, and whether or not the zona pellucida forms a barrier to infection in the ovary as well as in the oviduct and uterus. It may be that with some infectious diseases embryos are never exposed, because the causal agents do not enter the reproductive tract.

CONCLUSION

If embryo transfer is going to facilitate and reduce the costs of the international movement of blood lines by reducing quarantine requirements, or even rendering them unnecessary, research carried out on the transmission of infectious disease-causing agents by embryos will have to satisfy those responsible for formulating the regulations. This will require close cooperation and understanding between scientists and regulatory personnel.

It is also important that the embryo transfer industry be kept informed of current findings. The International Embryo Transfer Society has moved in this direction by establishing a sub-committee of its Import/Export Committee composed of scientific and industry representatives, with regulatory personnel in an ex officio capacity. The Society has also decided to establish an information bank for research in disease transmission by embryos, so that any person or organization interested in the subject will be able to obtain information on what is being investigated and by whom.

ACKNOWLEDGEMENTS

The author acknowledges with gratitude the data and helpful advice he has received from his colleague, Elizabeth Singh, and information regarding research in progress he has received from fellow scientists working in this field.
Table I. Studies reported and in progress on bovine embryo-pathogen interactions

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>In Vitro</th>
<th>In Vivo</th>
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</tr>
</thead>
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<tr>
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<td>+</td>
<td>+</td>
<td>Bouillant et al., 1981</td>
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<td></td>
<td></td>
<td>+</td>
<td>Eaglesome et al., 1982</td>
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<td></td>
<td></td>
<td>+</td>
<td>Olson et al., 1982</td>
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<td></td>
<td></td>
<td>+</td>
<td>Singh et al., 1982b</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Coulthard, unpublished data</td>
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<tr>
<td></td>
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<td>Bluetongue virus (BTV)</td>
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<td></td>
<td></td>
<td>Bowen et al., 1982</td>
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<tr>
<td></td>
<td></td>
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<td>Thomas et al., 1983</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bowen et al., 1983</td>
</tr>
<tr>
<td>Infectious bovine rhinotracheitis virus (IBRV)</td>
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<td>Parvovirus (BPV)</td>
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<td>Foot and mouth disease virus (FMDV)</td>
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<td>Akabane virus</td>
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<td>M. Paratuberculosis</td>
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Table II. Studies reported and in progress on ovine embryo-pathogen interactions.

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<td>Maedi-visna virus</td>
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<td>Dawson and Wilmut, unpublished data</td>
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Table III. Studies reported and in progress on porcine embryo-pathogen interactions

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<th>In vivo</th>
<th>Reference</th>
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<td>Bolin et al., 1982</td>
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<td>African swine fever virus (ASFV)</td>
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<td>Vesicular stomatitis virus (VSV)</td>
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<td>Swine vesicular disease virus (SVDV)</td>
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<tr>
<td>Enteroviruses (ECPO-3)</td>
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<td>(ECPO-6)</td>
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<td>Porcine cytomegalovirus (PCMV)</td>
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Table IV. Results to date on zona pellucida-intact bovine embryobovine leukemia virus (BLV) interactions*

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<tr>
<th>Transfers</th>
<th>Calves</th>
<th>Pregnancies</th>
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<tr>
<td>407</td>
<td>108</td>
<td>21</td>
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</tbody>
</table>

1) Embryos collected from BLV-seropositive dams and BLV-seropositive or BLV-seronegative sires and transferred to BLV-seronegative recipients.

2) All calves and all recipients have remained seronegative.

3) BLV could not be isolated from 60 embryos and 26 unfertilized ova collected from BLV-seropositive donors.

4) BLV was recovered from 4/25 flush fluids from BLV-seropositive donors, probably as a result of blood cell contamination.

* Eaglesome et al., 1982; Olson et al., 1982 and unpublished data; Singh et al., 1982b; Coulthard, unpublished data; Hare et al., unpublished data.

Table V. Results to date on zona pellucida-intact and hatched (10 to 11 day old) bovine embryo-bluetongue virus (BTV) interactions*

<table>
<thead>
<tr>
<th>Zona pellucida-intact</th>
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<tr>
<td></td>
<td>64</td>
<td>10</td>
<td>25</td>
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Hatched

<table>
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<td>19</td>
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<td>10</td>
</tr>
</tbody>
</table>

1) Embryos collected from BT-viremic (serotypes 10,11,13,17,18) dams and BTV-seronegative sires or BTV-seronegative dams and BTV-positive semen and transferred to BTV-seronegative recipients.

2) All calves and all recipients have remained seronegative for BTV. Calves and recipients tested for BTV isolation were also negative.

3) Forty-two normal embryos, 9 retarded embryos and 14 unfertilized ova were negative for BTV-antigen by immunofluorescence.

4) BTV was recovered from 12/34 flush fluids from viremic donors, probably as a result of blood cell contamination.

* Bowen et al., 1983; Thomas et al., 1983 and unpublished data.
Table VI. Results to date on zone pellucida-intact bovine embryoinfectious bovine rhinotracheitis/infectious pustular vaginitis virus (IBRV/IPVV) interactions*

<table>
<thead>
<tr>
<th>Transfers</th>
<th>Calves</th>
<th>Pregnancies</th>
</tr>
</thead>
<tbody>
<tr>
<td>72</td>
<td>20</td>
<td>14</td>
</tr>
</tbody>
</table>

1) Embryos collected from IBRV/IPVV-shedding (strains 108, Colorado) dams and IBRV/IPVV-seronegative sires and transferred to IBRV-seronegative recipients.

2) All calves and all recipients have remained seronegative for IBRV. Virus isolation attempts on selected calves and recipients have all been negative.

3) Virus has been isolated from 15/22 flush fluids from IBRV/IPVV-shedding donors.

* Singh et al., 1983 and unpublished data.
<table>
<thead>
<tr>
<th>IN VIVO:</th>
<th>Exposure</th>
<th>Transfer result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. embryos transferred</strong></td>
<td><strong>38 seropositive donors</strong></td>
<td><strong>22/34 pregnant recipients farrowed 208 piglets</strong>&lt;br&gt;<strong>(189 alive): no seroconversions</strong></td>
</tr>
<tr>
<td>805</td>
<td>3 donors infected intranasally with 2 ml—$10^6$ CCID$_{50}$/ml PrV after mating</td>
<td>0/3 recipients seroconverted</td>
</tr>
<tr>
<td>35</td>
<td>5 donors infected intranasally with 2 ml—$10^6$ CCID$<em>{50}$/ml PrV and intrauterinely with $.10^6$ CCID$</em>{50}$/ml PrV in 25 ml after mating</td>
<td>3/5 recipients seroconverted</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IN VITRO</th>
<th>Exposure</th>
<th>Transfer result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. embryos transferred</strong></td>
<td><strong>$10^4$ CCID$_{50}$/ml PrV</strong></td>
<td><strong>0/4 recipients seroconverted</strong></td>
</tr>
<tr>
<td>45</td>
<td><strong>$10^8$ CCID$_{50}$/ml PrV</strong></td>
<td><strong>5/5 recipients seroconverted</strong></td>
</tr>
</tbody>
</table>

*James et al., 1983; Bolin et al., 1982.*
REFERENCES


REPORT OF THE COMMITTEE
ON IMPORT-EXPORT

Chairman: Clint Booth, Texas

J. N. Armstrong, NV; Ken Baumgartner, IL; Joe Blair, DC; R. B. Caffey, MD; Dan Childs, FL; S. J. Cougar, TX; Jack Dahl, ND; R. L. Evinger, TX; W. H. Fales, MD; D. S. Gilhooley, Hawaii; R. C. Goulding, CA; John H. Gray, CO; W. B. Grene, FL; A. E. Hall, MD; Frank Harding, IL; Rube Harrington, Jr., IA; B. W. Hawkins, VA; D. E. Herrick, MD; James A. House, NY; R. C. Knowles, MD; Marlin L. Main, SD; Bob Mathis, AZ; M. E. Mix, VT; Robert Nicholas, CA; Brent Perry, TX; D. A. Price, CO; William Prichard, OR; G. B. Rea, OR; Charles Reid, FL; J. D. Roswurm, CA; R. M. Scott, MI; J. S. Walker, NY; H. A. Waters, VA; Carl R. Weston, NH; Walker Wilson, TX; George O. Winegar, MD

The Committee on Import-Export met on October 19, 1983, during the annual meeting of the USAHA, held at the Sahara Hotel, Las Vegas, Nevada. The meeting was called to order with 26 members and a total attendance of over 70 people.

The chairman asked the Committee for comments on last year's committee report.

Dr. D. E. Herrick, assisted by Drs. George Winegar and Sam Richeson reviewed the past year's activity of the APHIS Import-Export staff.

Dr. R. B. Caffey reported on the past year's activity of Plant Protection and Quarantine.

VETERINARY SERVICES REPORT
TO THE
IMPORT-EXPORT COMMITTEE OF THE USAHA

Import Animals

The regulations governing the importation of stallions from countries where contagious equine metritis (CEM) exists have been modified. We now require that all procedures relating to the treatment and specimen collection from the stallion and test mares be monitored by a State employed veterinarian. Test mares must now be permanently identified with a tattoo and can only be used once as a test animal for an imported stallion. Other changes which took effect on May 13, 1983, include a requirement that the stallion be cultured for CEM prior treatment, and that specimens could be sent to approved State laboratories rather than the previous requirement that all specimens be sent to the National Veterinary Services Laboratories, Ames, Iowa. The nine States approved to receive stallions from CEM countries are California, Colorado, Kentucky, Maryland, New York, North Carolina, Ohio, South Carolina, and Virginia.

The six States approved to receive mares from CEM countries are California, Colorado, Kentucky, New York, South Carolina and Virginia. Previously the regulations required that mares with incomplete clitoral
sinusectomies would be refused entry or sent for follow-up surgery to New York State College of Veterinary Medicine, Cornell University, Ithaca, New York. Effective April 1, 1983, the University of California Veterinary College, Davis, California, was also approved to perform surgery on those mares which arrive with incomplete clitoral sinsectomies.

Approximately 250 horses are expected to participate in the 1984 Olympic Games in Los Angeles, California. Importers may request a waiver of the CEM regulations and a waiver of the equine piroplasmosis (EP) test. Those horses entering the United States within 7 days after the Olympic Games. All horses will be monitored by Veterinary Services (VS) while on the Olympic grounds at Santa Anita Racetrack.

The new U.S. Department of Agriculture (USDA)-operated animal import center Los Angeles is scheduled to open in January 1984. The facility has 48 stalls and 48 cages for imported birds.

Public comments were solicited regarding current import requirements relating to the importation of horses from countries where CEM exists. The Department requested input as to whether the horse industry wanted additional CEM restrictions or deregulation of any or all CEM requirements. After reviewing both domestic and foreign responses it appears that VS will not make any major changes in the current CEM regulations.

VS has developed a proposed protocol for the importation of swine semen from the People's Republic of China (PRC). This protocol has been circulated to specialists in exotic diseases at Plum Island Animal Disease Center and the Emergency Diseases Program Staff, as well as personnel at the National Veterinary Services Laboratory (NVSL). There has been tentative agreement on the substance of the proposal, and it has now been sent to PRC to see if they will concur in a protocol which involves VS direct supervision of semen collection and processing in their country. At the time of this report, VS has been unable to reach an agreement on the provisions of the proposed protocol and are still in the process of negotiations with the PRC.

VS has developed a proposed protocol to permit swine from African swine fever, hog cholera, swine vesicular disease, and foot-and-mouth disease (FMD) affected countries to enter the United States through the Harry S Truman Animal Import Center (HSTAIC) at Key West, Florida.

A proposed protocol has been developed by VS to allow entry of cattle from Australia into the United States after meeting quarantine and health requirements in preparation for entry with a provision for post-entry quarantine at a USDA Animal Import Center.

Fifty head of cattle imported from France through the HSTAIC were released from the high security unit on March 22, 1983. Presently, testing is being conducted on cattle in France, Germany, Switzerland, and Austria to import 228 head through the import center. The cattle should arrive at the HSTAIC the middle of December.
On July 6, 1983, an interim rule was published in the Federal Register adding Chile to the list of countries declared to be free of rinderpest and FMD. Data furnished to the USDA establishes that FMD has been eradicated from Chile. The written comments period from the public on the interim rule was closed on September 6, 1983.

There has been considerable interest in importing llamas and alpacas from Chile. The first group of Chilean llamas and alpacas is scheduled to be imported in mid-November 1983 under health guidelines just recently developed.

Animals Imported:

<table>
<thead>
<tr>
<th>Animals Imported</th>
<th>FY 1982</th>
<th>FY 1983 Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>795,435</td>
<td>1,224,076</td>
</tr>
<tr>
<td>Swine</td>
<td>224,004</td>
<td>416,224</td>
</tr>
<tr>
<td>Horses</td>
<td>32,398</td>
<td>36,232</td>
</tr>
<tr>
<td>Sheep</td>
<td>8,968</td>
<td>9,980</td>
</tr>
<tr>
<td>Others</td>
<td>15,061</td>
<td>3,494</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1,075,866</strong></td>
<td><strong>1,690,006</strong></td>
</tr>
</tbody>
</table>

Estimated pending final reports.

**AVIAN IMPORT ACTIVITIES**

**A. Commercial Birds**

1. Velogenic Newcastle disease continues at a low ebb. There were ten quarantine lots of 9,303 birds refused entry, two lots from Peru, one from Tanzania, three from Bolivia, one from India, one from Honduras, and two from Indonesia.

2. One import commercial quarantine facility in California has had approval to operate removed by Veterinary Services because of violation of standards. Actions to remove approval on another facility in California and one facility in New York are nearly final. In four others, removal actions have been initiated.

3. The space reservation fee to quarantine pet birds, commercial birds, and poultry in U.S. Department of Agriculture (USDA)-operated stations
was increased from $40 to $80.

4. USDA accounting procedures have been changed and more complete and timely bills have been sent to operators this year.

5. A proposal is in the Federal Register which will allow quarantine stations to move between port servicing areas. Also, a few additional stations may be approved in areas where we have adequate personnel.

6. The U.S. Public Health Service has proposed to drop its import regulations on psittacine birds. However, USDA will continue to feed chlortetracycline to birds to prevent psittacosis. The two pet bird per family per year may no longer apply.

7. Commercial bird quarantine stations may now be sold with few restrictions. Previously, partnership agreements or stock sale of the old corporation were required.

8. Commercial birds will soon be imported through Harry S Truman Animal Import Center.

B. Pet Bird Program

1. Hidalgo, Texas, has been designated as a pet bird port of entry, replacing Brownsville, Texas.

2. Otay Mesa, California, will replace San Ysidro, California, as a port of entry for quarantining pet birds when the station is built.

C. Smuggled Bird Program

1. Construction of the new permanent smuggled and pet bird facility in Mission, Texas, was completed in June. Plans for one at Otay Mesa, California, have been drawn. These will replace the temporary buildings and trailers.

D. Poultry and Hatching Eggs

1. The regulation to allow hatching egg importations from viscerotropic velogenic Newcastle disease-free countries to enter the United States without quarantine will appear in the Federal Register in the next month.

2. USDA will continue to require foreign (except Canada) origin poultry flocks to be tested for Adenovirus 127 (part of import requirements for hatching eggs).

3. A regulation to require that flocks of origin be *Mycoplasma gallisepticum* and *M. synoviae*-free will be developed this year.

### STATUTORY OF CONSTRUCTION OF NEW VETERINARY SERVICES ANIMAL FACILITIES AS OF OCTOBER 1983

<table>
<thead>
<tr>
<th>Location</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles, CA</td>
<td>Quarantine Facility – Renovations are well along the way and should be completed by the end of November 1983.</td>
</tr>
<tr>
<td>Otay Mesa, CA</td>
<td>Smuggled Bird Facility – An additional $100,000 has been allocated to GSA by ASD in order to proceed with construction of the smuggled bird facility. Design and plans should be completed by November 1983.</td>
</tr>
</tbody>
</table>
1983 and the contract should be awarded by February 1984.

Mission, TX
Smuggled Bird Facility – Basic construction of the smuggled bird facility is completed. Shelving and cages should be constructed by December 1983.

Sweetgrass, MT – Land has been purchased and design and plans have been completed. Money has been approved for construction for FY 1984.

Detroit, MI
Border Port – The land that was originally selected was found unsuitable for construction. We are in the process of locating a new site.

Houlton, ME
Border Port – We are working with GSA on the plans for the facility. GSA hopes to award the construction contract this fall and have construction completed in 1984.
## Imported Birds (Commercial)

### Summary

<table>
<thead>
<tr>
<th>FY Period</th>
<th>Lots (Birds)</th>
<th>Lots (Birds)</th>
<th>Program Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Released</td>
<td>Refused Entry</td>
<td>Per Bird ($)</td>
</tr>
<tr>
<td>1974</td>
<td>13 (27,696)</td>
<td>6 (18,969)</td>
<td>9.23</td>
</tr>
<tr>
<td>1975</td>
<td>71 (124,597)</td>
<td>19 (30,446)</td>
<td>7.27</td>
</tr>
<tr>
<td>1976</td>
<td>179 (222,922)</td>
<td>24 (47,943)</td>
<td>6.27</td>
</tr>
<tr>
<td>1977</td>
<td>276 (313,537)</td>
<td>16 (35,197)</td>
<td>6.02</td>
</tr>
<tr>
<td>1978</td>
<td>409 (520,725)</td>
<td>12 (28,770)</td>
<td>4.41</td>
</tr>
<tr>
<td>1979</td>
<td>409 (941,174)</td>
<td>96 (32,296)</td>
<td>2.03</td>
</tr>
<tr>
<td>1980</td>
<td>428 (591,375)</td>
<td>15 (6,810)</td>
<td>1.53</td>
</tr>
<tr>
<td>1981</td>
<td>471 (518,472)</td>
<td>12 (21,182)</td>
<td>1.90</td>
</tr>
<tr>
<td>1982</td>
<td>391 (554,321)</td>
<td>13 (20,441)</td>
<td>1.87</td>
</tr>
<tr>
<td>1983</td>
<td>519 (619,751)</td>
<td>10 (9,303)</td>
<td></td>
</tr>
</tbody>
</table>

- **Worldwide pandemic VVND**
- **Federal funds**
- **Trust funds**
## Imported Pet Birds

### Fiscal Year 1983

<table>
<thead>
<tr>
<th>State</th>
<th>Total Received</th>
<th>REFUSED ENTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Birds</td>
<td>DOA</td>
</tr>
<tr>
<td>CALIFORNIA</td>
<td>690</td>
<td>10</td>
</tr>
<tr>
<td>FLORIDA</td>
<td>682</td>
<td>0</td>
</tr>
<tr>
<td>NEW YORK</td>
<td>845</td>
<td>17</td>
</tr>
<tr>
<td>HAWAII</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td>TEXAS</td>
<td>47</td>
<td>0</td>
</tr>
<tr>
<td>ARIZONA</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2,318</td>
<td>28</td>
</tr>
</tbody>
</table>

### Totals

- **BIRDS ENTERED (NOT QUARANTINED)**: 2,318, 2,162
- **BIRDS LABS**: 350, 467

* *WAD*
REPORT OF THE COMMITTEE

SUSPECT SWINE VESICULAR DISEASE (SVD) IN SWEDEN

In the summer of 1983, one pig in a shipment of swine exported from Sweden to Hungary demonstrated an SVD positive titer in Hungary. Swedish authorities investigated and collected diagnostic specimens from the herd of origin of the sero-positive pig as well as other herds within and distant from the area. Two pigs were found sero-positive — one from the same general area as the pig which had been positive in Hungary. No clinical evidence of SVD was observed in any herd examined. SVD experts from the Pirbright Virus Laboratory were called in by the Swedes to assist in their investigation. All specimens taken to Pirbright were negative and scientists there attribute the reported positive tests to cross reactions with antigens other than SVD virus.

Following the receipt of the positive serology report from Swedish officials eight containers of Swedish fresh pork were placed under USDA hold at ports of entry. These holds were released following receipt of information that the Pirbright report was negative. Swedish officials advise that they are continuing their epidemiological investigations.

FOOT-AND-MOUTH DISEASE (FMD) IN DENMARK

An isolated case of FMD was diagnosed January 13, 1983, on the Island of Funen following the last confirmed case on May 4, 1982. No FMD vaccine has been used in Denmark since 1977. Unless additional FMD is diagnosed, Denmark is likely to be considered FMD-free sometime in 1984.

SINGLE AGENCY PORT OF ENTRY INSPECTION (CONSOLIDATED BORDER CLEARANCE)

Presently sub-cabinet level meetings are being held weekly under OPM mandate between representatives of Customs, Immigration and APHIS. It seems rather certain that there will be some form of consolidated primary inspection.

ANIMAL PRODUCTS

In June 1983 Veterinary Services (VS) was notified that meat in a shipment of cooked frozen beef for Argentina was found not thoroughly cooked. This was found at processing in a U.S. plant in Iowa where part of the meat from the shipment had been sent. Some of the product had already been processed and was into retail commerce, beyond the ability to locate.

Tracings of the meat in that shipment showed that it went to several

IMPORT-EXPORT

points. After this shipment, three other shipments of undercooked beef were also found. All of the undercooked products came from the same establishment. What meat was not destroyed was reexported to Argentina and further shipments from the establishment were stopped.

VS took the position that no further shipments from that plant would be considered until an official report was received on the cause of the undercooking. It also would be required to show that remedial action was taken before new shipments from that plant would be considered.

The tracing down of the product and all related actions were the result of concerted actions by PPQ and FSIS together with VS.

During the year, considerable action was taken to find a way to continue the export of U.S. poultry products to supply U.S. military garrisons in the United Kingdom (UK). The UK stopped these shipments because of the purported threat of Newcastle disease (ND) introduction for the United States with the product. The problem was that the United States was stopped from exporting due to what some industry persons described as a nontariff barrier. The UK was trying to prevent dumping of poultry product from certain European countries. A program for eradicating ND was established in the UK, and imports of poultry product from countries having any form of ND was intended.

The United States requested UK officials visit certain poultry plants in Arkansas with the idea of finding a means to permit the former shipments to resume. The plants in Arkansas might be able to do so if the State would initiate legislation to control all ND.

Enterprising importers tried to import gamebird carcasses from the UK for the general U.S. market. A special one-time exemption was given, but was not extended at the importer's request. It was believed that the volume of gamebirds "shot in the wild" was 100 great not to be a man's production operation. Therefore, no further exemptions were given.

Venison from West Germany was intercepted at Dallas and Ft. Worth, Texas, by PPQ where it was destined for the Neiman-Marcus Company for sale. The product was mismanifested as chemicals. It was not found at the port of Atlanta where it entered, but was picked up at its destination. This kind of shipment puts APHIS on notice that similar kinds of shipments could be taking place under similar conditions at other ports.

There are eight options under consideration, seven of which presently include Agriculture as an independent entity at secondary inspection. APHIS takes no position relative to consolidated border clearance so long as the APHIS role in screening, secondary inspection, and management of Agriculture concerns at ports of entry is not diminished.

CURRENT STATUS OF PASSENGER BAGGAGE INSPECTION

The trend toward accelerated passenger clearance systems continues. At present, nine airports, including John F. Kennedy International Airport, Miami, Houston, and Los Angeles utilize various forms of red door/
green door passenger inspection systems. These nine airports handle over 80 percent of all inbound foreign flights. The various systems are designed to expedite passenger clearance by the three involved agencies (Customs, Immigration, and Agriculture). From the APHIS standpoint, the nine existing systems are all at least equivalent to if not actually superior to previous systems; however, APHIS operational costs for these systems have increased over those of former systems.

**INNOVATIVE INSPECTION TECHNIQUES**

The two aggressively trained detector dogs have proven to be very efficient in detecting prohibited animal products at international mail facilities. Military personnel at Lackland Air Force Base, San Antonio, Texas, will begin training nine additional dogs and six handlers in passive detection of prohibited animal products. This training is expected to begin early in calendar year 1984 and last 12 weeks. The new “teams” will work at international mail facilities and also begin tests at various international airports in passenger baggage areas. Presently, a test of an x-ray device is being conducted in San Juan, Puerto Rico. This machine enables officers to identify both animal and plant materials in passenger baggage. If this test confirms the system to practical, x-ray examination of passenger baggage for agriculture purposes may be extended to other ports of entry.

**CIVIL PENALTIES PROCEDURES**

Assessment of civil penalties for violations of APHIS regulations began August 1, 1983, for violations not involving passenger baggage, and are scheduled for November 1, 1983, implementation relative to passenger baggage. It has been very difficult to successfully prosecute violators of APHIS regulations under criminal statutes.

Enabling legislation was passed in January 1983 in response to an obvious need to improve the slow and costly criminal approach to Agriculture violations. Fines may be assessed up to $1,000 and serious cases deserving greater penalties may still be prosecuted under criminal law provisions.

**STATISTICS**

**Vessel and aircraft arrivals**

- 51,196 vessels boarded
- 3,712 lots consisting of 7,823,352 kilograms of garbage were removed from these vessels
- 5,422 garbage handling discrepancies corrected
- 278,623 aircraft arrived from foreign locations
- 29,840,335 kilograms of garbage were removed from these aircraft

**Meat and meat products refused entry/confiscated**

- ship passenger baggage
  - 157 lots
  - 524 kilograms
aircraft passenger baggage 61,406 lots 77,040 kilograms
border crossing 26,078 lots 30,676 kilograms
post office 11,513 lots 17,966 kilograms
commercial ruminant shipments 729 lots 211,548 kilograms
commercial port shipments 104 lots 80,683 kilograms
commercial poultry shipments 24 lots 2,282 kilograms

Meat and meat products checked
38,430 lots 496,135,743 kilograms

Footwear cleaned and disinfected
69,978 referred and inspected 5,601 cleaned and disinfected

Export certification
13,611 certificates 1,556,887,431 kilograms

Commercial animal products imported
4,230 lots 21,199,678 kilograms restricted entry
23,821 lots 469,221,696 kilograms unrestricted entry
255 lots 193,287 kilograms refused entry

ORGANISMS AND VECTORS

In Fiscal Year 1983, 1,007 permits were issued for the importation and interstate transportation of animal disease organisms and vectors.

An increasing number of requests are being made for the importation of cell lines and hybridomas. Since animal serum is used in the media to grow the cells, the possibility exists that such materials might be contaminated by animal pathogens and inadvertently lead to the introduction of exotic animal diseases into the United States. Cell lines from countries with exotic animal diseases are usually required to be safety tested in domestic animals at the Plum Island Animal Disease Center (PIADC), Greenport, New York, before entry into the United States is permitted. Since this is very time consuming and expensive for the importer, the Parent Committee on Foreign Pathogens and Vectors is considering the policy of in vitro or laboratory animal testing of cell lines and hybridomas for certain countries such as Japan or Australia, which have animal disease exotic to the United States, but which are not considered to be affected with foot-and-mouth disease (FMD).

Scientists at PIADC and the National Institutes of Health, are currently planning a study designed to establish an effective in vitro or laboratory animal test for the detection of FMD and other exotic pathogens.

An agreement was signed June 1, 1983, between representatives of the U.S. Department of Agriculture (USDA) and the People's Republic of China (PRC) concerning the import requirements of the PRC for cattle, swine, and poultry and hatching eggs. Representatives of U.S. exporters were on hand for consultations regarding the Chinese requirements on the U.S. export industry. The agreements were signed, recognizing the Chinese requirements, but the PRC representatives were advised that there would be little or no exports under the conditions set forth since USDA did not consider them practical even though technically possible.

Several meetings have taken place in the livestock export industry and recommendations for changes in the agreements have been made. Drafts of revised agreements have been sent to the PRC for consideration.

A group of U.S. representatives, Mr. William McMillan, Assistant Secretary of Agriculture; Mr. Bert Hawkins, Administrator, Animal and Plant Health Inspection Service (APHIS); Dr. John Atwell, Deputy Administrator, Veterinary Services (VS); Mr. John Riesz, Foreign Agriculture Service; Mr. Sam Wong, Office of International Cooperation and Development; and Mr. Marion Strothers, Livestock Exporter, went to the PRC on October 4, 1983, to attempt to resolve the impasse. No agreements for semen or embryos were negotiated with the PRC.

User fees that were to be implemented for services performed that were reported in 1982 have not been instituted as the proposed legislation has not passed.

Routine testing of samples taken from animals intended for export has been sharply curtailed at the National Veterinary Services Laboratories (NVSL) due to personnel and budgetary limitations. Some countries specifically require that the tests be conducted at NVSL and every effort has been made to comply with these requests.

A new export facility, Pet Air, in San Francisco has been approved. Los Angeles has been approved as both an air and ocean port. These changes are scheduled to appear in the Federal Register in the near future.

Korea continues to be the major export market for cattle. Swine, in large numbers, are being exported to several countries in the Orient.

The large scale vesicular stomatitis (VS) outbreak of 1982 has not recurred this year as expected. Most states have now passed 1 year with no positive cases documented. The positive cases were west of the Mississippi with the exception of two positive feral swine on Ossabow Island off the coast of Georgia. The outbreak caused considerable concern in countries importing U.S. livestock and some embargoes were instituted. Taiwan still will not accept animals from a state that has had a positive diagnosis of VS in the past 12 months. Most other countries will not accept animals from a specified radius around a positive focus for 12 months, but accept negative animals from outside this area.

Little difficulty has been experienced with serum neutralization (SN)
testing at 1:8 dilution for VS in cattle, but swine exporters have had some difficulty in finding complete herds negative at the 1:8 dilution. Some exporters feel a 1:32 dilution would be more appropriate for testing swine where no clinical evidence of VS exists.

The number of export animals has decreased this year. A large part of this is due to the drastic reduction in the numbers of animals exported to Mexico. It is hoped that an increase in the Asian market will offset this decrease in Mexican imports.

There has been no indication that the European Economic Community (EEC) will relent on their requirements regarding bluetongue (BT) and enzootic bovine leukosis (EBL). Discussions with industry representatives have resulted in suggestions on how the EEC could import U.S. livestock without fear of importing either of these two diseases. Those proposals include quarantining the animals in a northeastern state after the vector season for BT or placing the animals on the French islands off Canada for a quarantine period. The Import-Export Animals and Products Staff propose that the EEC consider the above as well as asking for allowing a certain titer level, virus isolation by sheep inoculation, or modification of their import regulations.

Great Britain did not accept U.S. semen from the 1982–83 collection season. Negotiations have taken place and plans are complete for a 1983–84 collection. The guidelines allow for satellite semen collection centers and allow more flexibility than last year. Samples of sera and semen will be tested at NVSL and Pirbright prior to export.

Embryos are being exported in greater numbers and are expected to continue increasing in numbers. Research is being conducted to determine the safety of exporting germplasm in the form of embryos. It appears that embryos are a very safe way to export germplasm.

Irregularities in certifications for export cattle and embryos have been noted this year. Efforts continue on the part of VS to prevent unintentional and/or intentional errors on export health certificates. It will take the efforts of all concerned-industry and government to protect and expand the exportation of U.S. livestock.

Data on animals exported in FY 82–83 are as follows:

<table>
<thead>
<tr>
<th>Year Ending September 30, 1982</th>
<th>Canada</th>
<th>Mexico</th>
<th>Other</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>85,540</td>
<td>69,825</td>
<td>14,960</td>
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<td>Horses</td>
<td>58,527</td>
<td>21,681</td>
<td>2,379</td>
<td>82,587</td>
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<td>Sheep/Goats</td>
<td>48,600</td>
<td>322,040</td>
<td>1,170</td>
<td>371,810</td>
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<tr>
<td>Swine</td>
<td>2,402</td>
<td>35,399</td>
<td>14,925</td>
<td>52,726</td>
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<tr>
<td>Total Livestock</td>
<td>195,069</td>
<td>448,945</td>
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<td>4,041,839</td>
<td>14,487,034</td>
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<tr>
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<td>5,760,919</td>
<td>3,699,659</td>
<td>14,586,709</td>
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Year Ending September 30, 1983

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<th>Mexico</th>
<th>Other</th>
<th>Totals</th>
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<td>16,206</td>
<td>5,357</td>
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<td>Horses</td>
<td>33,576</td>
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<tr>
<td>Sheep/Goats</td>
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<td>Swine</td>
<td>692</td>
<td>2,501</td>
<td>34,813</td>
<td>38,820</td>
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<tr>
<td>Total Livestock</td>
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<td>152,981</td>
<td>74,998</td>
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<td>Poultry</td>
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<td>Semen</td>
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<td>2,7 Million Units</td>
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</tr>
<tr>
<td>Embryos</td>
<td></td>
<td></td>
<td>2,365 (Estimated)</td>
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</table>

Dr. Harold A. Waters gave the report of the Export Sub-Committee which is included as Appendix I.

Dr. T. D. Rich, representing U.S. Beef Breeds Council, spoke on their concerns on health regulations by importing countries. His remarks are included as Appendix II.

The import and export of embryos was discussed and the chairman told the Committee that a sub-committee would be formed to deal with the procedures and protocol.

Three resolutions were passed by the Committee and have been presented to the Resolutions Committee.

There being no further business, the meeting was adjourned.

EXPORT SUBCOMMITTEE

The Export Subcommittee met at 1:30 pm October 18, 1983.

Thirty USAHA members were present, nine of which were subcommittee members. Eleven persons were from industry, nineteen represented government.

H. A. Waters, Chairman, reported that the Export Subcommittee met with Secretary McMillan on September 27, 1983. Seven members and President J. R. Ragan were present. A general discussion was held regarding export livestock health certification and facilitation. Drafts of USDA position papers (endorsed by LEA) for renegotiation of China import health requirements for cattle and swine were received from VS. These drafts have been forwarded to both the Committee on Import and Export and the Export Subcommittee members for their direct comment to Dr. John Atwell. USDA's role, structure and action for promoting, facilitating and expediting of animals and germplasm from the United States was also discussed.

Bert W. Hawkins, Administrator APHIS reported on the recent health negotiations with the Chinese. Last week in Beijing the cattle, poultry and swine agreements were modified but remain impractical.

A national disease reporting system necessary for a meaningful health
certification system has been initiated in Ohio and Tennessee. Pilot projects are to be started in four additional states.

He requested that ethics for livestock exporters be developed to avoid sending unqualified animals.

APHIS has established guidelines for exportation of livestock, they include:
1. Increased APHIS monitoring of animals being prepared for export.
2. Monitoring for preconditioning, including adequate feed and water prior to shipment.
3. Investigation of suspicious tests and certification.

John Atwell reported for the OIE Zoo Sanitary Commission. They have bovine leucosis, brucellosis, leptospirosis, Rift Valley fever, equine infectious anemia, and embryo standards under review. George Winegar reported on the Export Animal Health Program.

Joe L. Blair reported on FSIS International Programs. FSIS import standards become the requirements of other countries for US meat. FSIS has an attaché in Brussels to aid negotiations with EEC. They plan to assign an attaché to the Far East and a technician to the Middle East to further meat exports.

William A. Bailey reported on transportation research. A copy of his report is enclosed. Dr. G. H. Snoeyenbos announced a Salmonella seminar July 19–20, 1984 in New Orleans.

Graham Purchase reported on ARS research on Caprine arthritis and on caseous lymphadenitis.

HEALTH RELATED PROBLEMS IN TRANSPORT OF ANIMALS

By William A. Bailey and B. Hunt Ashby

Animals certainly have been transported by man for as long as they have been domesticated. The first written reference to animal transportation, probably, is the story of Noah’s Ark. Throughout history there are many references to the close association and dependance of the family on their livestock for food and wealth. Thus selling and transport of animals was born, and it is certain that health problems such as injuries, stress, parasites, and diseases have been associated with domesticated animals from the beginning.

Today, livestock producers and shippers in the United States and Canada are transporting animals up to 3,000 miles for domestic markets and up to 12,000 miles for export markets. Trucks, trains, and airplanes are used for domestic transportation. Airplanes and ships are generally used for export markets.

The time and distance relationships of the various vehicles used to transport animals are important factors to consider in planning and executing animal transport.

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1/ Agricultural engineer and agricultural marketing specialist, respectively, Transportation and Packaging Research Branch, Office of Transportation, U.S. Department of Agriculture, Beltsville, Md. 20705.
Transport animals are shown in figure 1. As you can see, it is possible to fly anywhere in the world in 25 to 40 hours plus the refueling time. Anywhere in North America can be reached in less than 10 flying hours. The slower ships could take up to 50 days to reach a port 12,000 miles away as many GI's learned during World War II.

Each species, sex, age, pregnancy, and condition of animal; type, size, and speed of vehicle; weather conditions at origin, during transport, and at receiving location; and handling stresses before, during, and after transportation all affect the health of the animal. Stresses are difficult to describe or evaluate, since the effect of the stress may not show up for several days. The following stresses should be minimized before, during, and after transportation: (1) Excitement, (2) overheating, (3) chilling, (4) humidity, (5) crowding or isolation, (6) fright, (7) noise, (8) injuries, (9) slick floors, (10) bedding, (11) high CO₂/low O₂, (12) sexual, and (13) feed/water.

1. **Excitement** — A nervous animal in strange surroundings can try to escape which could cause injury to itself or handlers. Its heart and breathing rate and temperature may rise to a critical level. To lower the animal’s stress, avoid bright lights, shadows, and noise.

2. **Overheating** — Most animals cannot tolerate overheating as well as human beings and will die if their temperature reaches a critical level. Avoid conditions that lead to overheating such as crowding and running. If you cannot avoid overheating, cool the animals by spraying with a light mist of water and ventilate with a fan, or if transporting in an open vehicle, let the air circulate over the animals. On the other hand, care must be taken not to chill the animals with excessive spray or wetting and ventilation.

3. **Chilling** — While most mature animals can take chilling better than other stresses, the young suckling or just weaned animals are more sensitive to cold. When subjected to chilling transport conditions, the animals and their bedding must be kept dry and air movement over the animals kept to a minimum.

4. **Humidity** — Most animals maintain body temperature by evaporative cooling through the lungs such as a dog panting or through sweating such as a horse or some combination of these methods. It, therefore, is desirable to keep the holding or transport area at a low RH to facilitate natural animal cooling.

5. **Crowding** — Excessive crowding will stress the animal by: (a) excess heat buildup due to skin contact with other warm bodies and to less natural cooling by convection, and (b) nervous exhaustion due to discomfort and failure to get adequate rest. If shippers will use the space guidelines published in the CFR Part 9 Export/Import Regulations and other publications (table 1), there should be no problem with crowding or heat buildup due to crowding.

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6. **Fright** — A frightened animal can cause dangerous injuries to itself or its handlers. Large animals such as steers or horses may cause damage to expensive transport equipment. To avoid fright, eliminate loud noises, bright lights, shock sticks, excessive use of force, steep inclines, and slippery floors. Talk softly to the animals and use a slight hand slap to get the animal to move. Caution: Never enter a pen used for mature male animals. Many farmers and animal handlers have been injured or killed by a stallion, bull, or boar.

7. **Noise** — Loud unusual noises such as a vehicle backfiring, or banging of metal objects can spook or scare animals. Avoid this unnecessary stress on the livestock being transported.

8. **Injuries** — Most of us have observed injury causing spikes, sharp boards, loose wire, sharp sheetmetal, etc., around the holding pens and sometimes in the transport vehicle. To avoid injuries to the animals and people handling the animals, remove or repair protruding objects that can cut, puncture, or otherwise cause injuries.

9. **Slick floors** — Many animals are injured from sliding on slick concrete, metal, wood floors, and loading ramps, especially in trucks and on ships. A rubber or soft vinyl flooring with a tread is more desirable, but a coarse brush finished concrete, straw bedding, or deep sand layer is satisfactory in the holding pens or in the transport vehicle. Proper size and space treading on loading ramps is a must.

10. **Bedding** — The bedding should provide the animal with a clean, dry, and comfortable bed to stand or lie in. A false flooring made with soft vinyl covered metal over a waste storage pan works well. Straw bedding that is recovered each day of the trip makes a good bedding for animals aboard a ship. On air shipments of pigs, popcorn is a good bedding, since it is lightweight, sterile, absorbent, and nutritious.

11. **Lack of oxygen** (or excessive CO₂) — When animals are crowded and confined in an enclosure such as an airplane, closed truck, or tight crate, the oxygen will be depleted and the CO₂ will rise to critical levels unless positive ventilation is provided. This condition along with excessive heat, especially in an airplane sitting on the ground, has caused many deaths.

12. **Sexual** — Mature male animals must be transported in single crates or stalls away from female animals in heat. Bulls, stallions, or boars will fight and injure each other in an attempt to reach a receptive female. Some shippers reputedly quiet stallions by applying mentholated petroleum jelly on their noses.

13. **Feed and water** — The easiest stress to avoid, especially in the shipping or receiving pen, is water to quench the animals' thirst. For the past 2 years, aircraft pens for swine are equipped with nipped water supply. At Beltsville we have been experimenting with providing feed and water on railroad cars and piggyback livestock trailers. The shrink and probable adverse health effects on livestock shipped without feed and...
water are very costly. In a recent shipment of feeder calves from Tennessee to Texas, 100 calves shipped normally lost 9.7 percent of their weight during the 26.5-hour highway trip, while an equal number on the piggyback trailer lost 2.25 percent during the 4-day railway trip. The shrinkage loss of each highway transported animal was approximately $5 more than the cost of the feed and shrinkage of the rail animals. This loss on top of an extremely stressed lot of animals may change the attitude of the cattle buyers in the future.

Some of you may think of health problems more in disease related terms. However, physical stress and disease factors are often interrelated. Our mission is engineering and developing better equipment and transportation systems. We accomplish this by work with veterinarians, animals scientists, and the livestock industry in general. Today, we have a large array of new instrumentation to assist in our mission. For example, we have made extensive use of TV monitoring equipment to study the reactions of livestock under transport conditions. Factual information about livestock stress during transportation is lacking. Although, recent advances are being made through efforts of scientists with the help of new equipment.

If any of you wish to read more or discuss any transportation problem, we will be glad to work with you. The references listed may help you with your transportation related problem.

CONCERNS ON HEALTH REGULATIONS BY IMPORTING COUNTRIES

Dr. T. D. Rich, President
American Polled Hereford Association

Although professionally I represent the American Polled Hereford Association, today I have the added responsibility of speaking on behalf of the U.S. Beef Breeds Council (USBBC). This council has the purpose of solving common problems and is made up of the executive officers of 15 beef breed associations. One of our current problems is the trend of export health regulations. In short, we find them excessive, frequently used as non-tariff trade barriers, and bordering on discriminatory.

Beef cattle is one animal that can convert a non-human consumable, naturally re-occurring resource (grass) into a highly nutritional and healthy human food, “beef”! There are literally millions and millions of acres of land around the world that are most suited for growing forages. This land is too steep, too rough, too wet, too dry or too something to place in cultivation but it can grow grass and it can produce beef. The membership of our associations make up the purebred sector and are a part of the total industry. Our main purpose is producing and selling predictable genetic material for the millions of commercial cattle. Primarily because of this country’s application of genetic principles, technology and science, purebred beef cattle breeders in the U.S. have established themselves as the world leader in beef cattle genetics.
In addition to producing superior genetics, U.S. breeders are very skilled in the art of promotion and sales. Results are that a market for U.S. genetics has developed around the world. Health regulations, trade restrictions and/or political climate frequently overshadow demand and may block U.S. breeders from participating in the very market that their genetic engineering skills developed.

The point I am trying to make is, the U.S. purebred beef cattle breeder has been and will remain at the forefront for genetic material around the world. Those peoples involved in the development of health regulations for export should remember that fact. Health regulations should be written such that the individual animal breeder is not denied access to export markets. Health regulations should be fair, effective and nondiscriminat-

Who in the U.S. sells genetic material? Maybe each of us would define these groups a little differently but I group them as purebred breeders, order buyers (exporters) and genetic companies, (A.I. studs and embryological laboratories).

Order buyers for the most part bid on a tender that some importing country has placed on the market. These tenders are generally given to the lowest bidder and because of that, the order buyer bids the lowest amount for which we can procure cattle. These cattle are most likely of unknown parentage and genetic merit.

Genetic companies may consist of A.I. studs or embryological laboratories. These types of organizations frequently buy or lease what they believe to be superior animals. They may or may not invest more money to prove that animal as above average for the breed. That animal then enters into an environment whereby the company can hopefully get a positive return on its investment by selling the genetics of that animal.

Breeders on the other hand have the factory that produced the genetics merchandised by the genetic company and order buyer. The breeder produces a new crop each year and is constantly striving to produce one that is genetically superior to the last. Because of skills, knowledge of genetics and technology, it is quite likely that he will produce a better one. Couple that fact with promotion, salesmanship and human nature to have the latest model and you have a situation where many seed stock breeders of other countries prefer to buy from seed stock breeders. Because breeders are in the business of producing breeding value, you also have a situation where the best genetics in the U.S. will, more than likely, be in the ownership of breeders. This latter statement will be true because they are the engineers of genetic advancement. They produce the ones that every one else sells.

It is also important to look at who buys genetic material. Importers may be governments interested in numbers; retailers who are interested in reselling for a profit; commercial cattlemen interested in buying volume of genetics (primarily semen); and, seed stock breeders wanting the best genetics because of its value to their domestic programs. Genetic merit is
normally of secondary importance to profit potential or building inventory to governments and retailers. Cattlemen (commercial and seed stock producers) will have genetic merit much higher in priority, than governments or retailers. If breeders are going to the expense and trouble to import, they will reach for something better than they have at home. They generally reach for what they perceive to be the best and the best genetics will be in the ownership of breeders.

Some of the problems we have encountered in export health regulations can be described as:

1. Health regulations of importing countries exceeding their capabilities of detection.
2. Failing to distinguish between vaccination titers and disease infection titers, or failing to acknowledge that some diseases are controlled by calfhood vaccinations.
3. There are indications that on more than one occasion, our own people have been more help than breeders can afford by recommending regulations to importing countries.
4. Situations where health regulations are used as a non-tariff trade barrier.

U.S. breeders of purebred seed stock are not against health regulations. We are against excessive regulations that favor one group of sellers over another. It is our belief that the superior genetics in this country will continue to be in demand around the world, that much of those superior genetics are in private ownership now and will continue to be in the ownership of private breeders. Health regulations of both the importing and exporting country should not deny market accessibility to the breeder. Health regulations should be effective but not prohibitive, they should be fair but not discriminatory, and they should be adequate but not excessive.

Members of the Import-Export Committee of USAHA, are intelligent people. Your knowledge is sought by others. Decisions you make or recommendations you suggest are heeded. Directly and indirectly, you have an impact on health regulations. As a representative of breeders, I ask that you consider all facets of the industry when recommending or advising policy.

I would like to thank this committee, its chairman and members for allowing USBBC the opportunity to express our concerns.
IOWA SWINE IDENTIFICATION
By Charles Rutenbeck, Special Aide to
The Iowa Attorney General

W. R. Rasty, an Iowa pork producer, is the principal catalyst behind the swine identification program. Rasty tells the story about the theft of 30 feeder pigs. In a rural community it is not unusual for the sheriff to know who steals the livestock. When the farmer reported the theft, the sheriff scouted the farm where he thought he could find the pigs; sure enough, it appeared they were there. The sheriff took the farmer to that farm. The pigs were identified by the ear notches and by one pig that had a lamp burn on his back. The farmer had recorded the notches. Of course, that farmer knew his own swine, but this type of identification was not good enough for the court. The thief was not only released, but the pigs were returned to him and he was permitted to sell them. The sheriff was lucky he was not sued for false arrest.

The courts today demand positive identification. The crook of today must be caught with a "smoking gun" in his hand or he walks free.

A swine identification program is now in place in Iowa. The prime reason for this identification is to deter theft. The swine producer applies to the county sheriff for his 10-digit crime identification number.

There are no duplicate numbers. The producer then orders his tattoo through the crime prevention office in Des Moines, Iowa at a cost of $46.80. He will then receive a tattoo pliers that has a removable head consisting of two lines, five digits on each line. This head is small enough to place the tattoo number on the outside of a day old pig's ear. Once the tattoo has been applied, it is legible throughout the life of the pig. A green tattoo paste is included. This paste has U.S.D.A. and F.D.A. approval. One tube does approximately 500 pigs.

When a producer orders his tattoo kit, he also receives a large reflective sign stating that his or her livestock have the tattoo I.D. It is recommended that he place this sign in a conspicuous place to deter theft.

In Iowa, we have a very simple procedure of obtaining a crime protection number. To obtain that number the farmer calls or sees his own county sheriff. He fills out a simple application and is immediately assigned a number. My number is IA, Iowa; 077, Polk County; 1205R is my personal number. The (R) designates the first letter of my last name; thus making it easier for the sheriff's office to recall my number or name quickly. There are well over a million combination of letters and numbers within the first four digits, enough to satisfy the most populous counties.

On occasion, I have called various sheriff's officers in Iowa asking them to give me the person's name, address and phone number of a certain 10-digit crime I.D. sequence. Generally, I can get that information within three minutes. That is better than six months it recently took me to run down a cattle brand.
There are other advantages to this tattoo I.D. system. If a market, packer or livestock buyer receives stolen livestock, the agents or buyers can end up paying twice for the livestock. I know of two cases in Iowa where stolen livestock was traced to a market. A replevin action was brought against the market and monies were recovered for the theft victim. A feeder pig market generally knows his sellers. It is an unusual occasion when the market sees a complete stranger. If those pigs are carrying a tattoo I.D. number on their ear, a quick call to one’s own sheriff or to the sheriff of the numbered county can quickly bring the name of the owner of that sequence. A few minutes time could save that market a lot of legal problems and dollars.

Iowa believes that this program offers many advantages for a livestock producer. I would like to take just a moment to list a few of the more obvious potential advantages to participation in swine identification.

1. A sign out front will probably send a thief down the road. The thief of today knows all about identification.

2. With this program there is a far greater chance for the recovery of stolen livestock. In Iowa when a theft of tattooed livestock is reported to the sheriff, the description of the livestock along with the tattoo I.D. number will be put on the Iowa computer hot sheet. The various county sheriffs will inform their local markets and buying stations to be on the alert for the identified livestock.

This is a program that the Iowa sheriffs are very enthusiastic about. They have been cursed time after time by their farm constituency because it appears the sheriff will or can do nothing. When in fact it is the courts that have tied the sheriff’s hands. Even if the sheriff found the unidentified livestock he could do nothing. That is hard to explain to a farmer that just lost 60 head of 70 pound pigs.

3. After a period of time in which to analyze the effect of the program, I believe insurance companies will offer a premium reduction for participants.

4. Identified feeder pigs may bring a premium price at market. If a producer has pride enough to put his name on his livestock, I believe, buyers will respond. Those producers that are willing to identify their livestock in all probability are the ones that do a better job with their livestock.

5. Not all finished swine sold to buying stations have chemical residues. If our program is generally accepted a fair number of fat hogs sold to buying stations will carry the ear I.D. It will make the trace back through the buying station easier for residue or other disease problems. Even if the problem swine are not those tattoo identified, it reduces the number of farms left to be checked.

This should constitute an overall improvement in the red meat industry. Anything that helps stop adverse headlines, does help.

Mr. Patrick Jackson recently spoke to the National Livestock and Meat
Board. Mr. Jackson has a firm that specializes in helping industries speak to or avert problems. His speech concerned possible damages in the livestock meat industry. It was his opinion the greatest potential "real killer" of the livestock meat industry could be the residue issue. I believe it is obvious that herd identification can do much to help stop this potential industry killer.

On the national level, there are many, different property I.D. systems that are used as a theft deterrents and aid in the recovery of merchandise. There are even different systems within some states. Nevertheless, there are presently approximately 35 states that are using the 10-digit system. I do not believe this diversity in systems is necessarily a blow to a uniform system for identification of livestock using the 10-digit system. No other I.D. system has spoken to livestock. This special tattoo tool used is only manufactured by one company. This system is under control since this Crime Prevention Division in Des Moines is the only place it can be ordered. Our next step is to seek the support and endorsement of the various national livestock associations and the National Rural Crime Commission. This can be accomplished. The National Association of Attorneys General Farm Division Ag Alert is the first national affiliation to support this program. That support will continue. Even if a state or local I.D. that has a differing basis, we can get the 10-digit identification system adopted. If local farmers of livestock associations request their own sheriff to set up a specific recording system for livestock that sheriff will surely recognize the value of the program for law enforcement and adopt the system.

It is tremendously important that a veterinarian or animal health official have the ability to find out what farm has a problem with their livestock. It would be great if they could call a local sheriff to find this information.

The final benefit of this program is undoubtedly obvious to this group. Identification for health reasons is one of the tools we need in this county for better animal health. Yes, it would be nice if we had a mandatory computer chip in each head of livestock in the United States. I hope that day will come, but until it does, I see this program as a minimal cost program that is a step that we have neglected to take in other forms in the past years.

I believe this same program can work with all livestock in every state in the nation. We are now organizing test programs for both sheep and cattle. This system of identification is positive. In my opinion it is superior to branding or tagging.

In Iowa a number of major organizations have endorsed this program as you note on the front of the pig I.D. ear tattoo pamphlet. There is a lot of quality in these endorsements.

I am not only speaking for the Farm Division of the Iowa Attorney General's Office but also for the Ag-Alert Network which is a division of the National Association of Attorney Generals. I am speaking for them
and for the other associations that have already endorsed this program. I respectfully request the United States Animal Health Association to consider one small step. Endorse this program. It was not originally started to help give better animal health, but it can, with your endorsement many of us will carry on from here, hopefully to give you a tool that is not now in your bag.

Thank you.
BOAR IDENTIFICATION—ELIMINATION OF TATTOO
USAHA Identification Committee
Neal Black, Livestock Conservation Institute

The Swine Brucellosis subcommittee has, for several years, been attempting to establish whether or not cull boars at slaughter would be an appropriate surveillance medium for discovering infected herds. This desire is prompted by our failure to effectively carry out the current Market Swine Testing program, which involves testing cull sows and boars at slaughter, traceback to herds of origin and appropriate action in infected herds to eliminate the infection.

The major problem with that program is identification; our inability to trace back to the herd of origin a significant percentage of the positives. There are about a fifth as many boars going to slaughter as sows, and we would need to test at only about a fourth as many plants to sample nearly all the boars, as would be required to obtain samples from the same percentage of sows. That gives you an idea why we are interested: emphasis on boars only could increase efficiency of the program while saving costs.

There are obviously two questions to be answered. The first is whether or not boars from infected herds would be positive at slaughter. Studies are under way to answer that question, but even if only half the boars from infected herds are positive at slaughter, the program could be more effective than the current effort with a very low percentage of tracebacks.

The other question is the one that brings me here today. It involves the efficiency of the identification of boars. Studies conducted to date indicate that boars can be identified, with ear tags, through the marketing process. That identification can be recovered when blood samples are obtained at slaughter and used in tracing back to the herd in which that boar served its reproductive life. Dr. Phil Pickerill, federal veterinarian in charge in Iowa, who originally proposed the emphasis on boars in the swine brucellosis MST program, has done much of the analysis on the potential for this change, as well as the research on identification. He concludes that experience in Iowa indicates a boar identification program could be successful. They have even been able to trace boars originally sold by breeding companies on the basis of the identification tags affixed to the boars by the companies before they were sold as breeding animals. In the Iowa studies, boars have been successfully traced to the farm at the rate of 90%, when they were eartagged. In one test of 10 eartags recovered from boars slaughtered in another state, the Iowans were able to successfully trace 9 and were confident they could have traced the tenth by rooting through records already in storage, Dr. Pickerill said.

Why eartags? Now we're getting to the subject of the motion from the swine brucellosis subcommittee and of this presentation.

As you know, the slap tattoo is a valuable identification method when hogs are scalded and dehaired so the tattoo can be read. Its major dis-
advantage is that it cannot be read until the hair is removed in the slaughter process; thus it cannot be read when the hog is alive. Even more important, it is impossible to determine on the live hog whether or not a hog has been tattooed, especially on colored hogs. This has obvious implications on enforcement. If tattooing is an option and it is claimed that a hog is tattooed, that cannot be confirmed or refuted until the hog is dehaired. So if the hog had not actually been tattooed, by the time that is determined it’s too late for enforcement.

Obviously, the tattoo is less valuable when hogs are skinned in the slaughtering process, a growing trend, since the tattoo is often lost entirely, depending on the skinning procedures used. However, the disadvantage of tattooing is true whichever method is used in the slaughtering process, scalding and dehairing or skinning. Enforcement of any identification requirement is difficult, if not impossible, if the tattoo, rather than an externally visible means of identification, is used.

The fact that an estimated 80% of boars are skinned, making the tattoo ineffective as an identification methods, is of interest, but not a major consideration in this discussion. The fact is that whatever method is used, eartags, or some other identification visible on the live hog, are the only acceptable identification from an enforcement standpoint. Note that I would include electronic identification among the acceptable means of identification, assuming that the fact of identification can be confirmed before the opportunity for enforcement of an identification requirement is lost.

Dr. Pickerill tells me the major problems of identification in his research involve lack of cooperation by dealers, who claim boars going to slaughter are identified—tattooed—when they are not; also those who fail to identify because the neighboring state does not require it, or because their competitors aren’t required to do it. The solutions to these problems involve a uniform system, universally and uniformly applied, that can be enforced.

A change in the federal regulations to eliminate the option of tattooing of boars for identification is needed. Our subcommittee has asked for that change. APHIS has indicated it is waiting for the results of its studies on boar identification and the value of the boar in a surveillance system. While I am confident that the change to emphasis on testing of boars will be implemented, I would suggest that even if it is not, we must consider either eliminating the tattoo as an approved identification for regulatory programs or developing a system for confirming compliance with identification requirements on the live hog, as well as solving the problems of recovering tattoo identification when hogs are skinned. Problems with enforcement and the increase in skinning at hog slaughter plants make this imperative. It is no less imperative in view of renewed interest in mandatory identification of all slaughter hogs. These questions must be considered in deliberations on that issue.
All too often in our business dealings through force of habit, we overlook the obvious. It reminds me of the story of the two hunters who went on a Moose hunting trip in Canada. They were flown in to an isolated hunting area and the pilot told them he'd be back in a week to pick them up. He cautioned them that they could only take out one moose as that’s all the added weight the plane could carry. When he returned they had two moose. When the pilot reminded them of the weight and balance limitations they protested saying that, “Last year the pilot said the same thing but we tied one under each wing.” The new pilot said, “Well, maybe I miscalculated so if they did it last year we can do it this year.” So one moose was tied under each wing and they took off. Unfortunately the added weight was such that they couldn’t gain enough altitude to clear the ridge and they crashed into the side of the hill. After a little while they started to come to and one hunter asked the other, “Where are we?” The other looked around and replied. “About 100 yards to the left of where we crashed last year.”

For many years we’ve tried, “crashed” and tried again to find an identification system for pigs that would be easy to do, permanent, inexpensive and accurate. Several systems have been used with varying degrees of success such as ear tags, paint or dye markings, ear notching and body tattooing. Our company, STONE Manufacturing, has been engaged for two generations in the identification of animals and we’re familiar with the products used in these processes and have, in fact, been a major supplier for some of the instruments used.

My father was one of the pioneers in the development of tattoo equipment for use on the internal area of the ear in livestock and lip tattooing in horses. However, this type of tattoo equipment was entirely too large or cumbersome to even think of being used on pig’s ears.

It wasn’t until about five years ago when we developed a new very small tattoo plier (which we called the PET TATTOO) that it became mechanically possible to show pig’s ears.

This instrument was called the “#300 Pet Tattoo” because the digits or numerals were only 300 mm high with 4 digits requiring a space of only 1-1/4” and 6 digits requiring only 2” of space.

About a year ago we were contacted by Mr. W. R. Rasty, a major swine producer in Lohrville, Iowa concerning the possibility of using our new small tattoo to tattoo the external portion of a pig’s ear. We made a prototype instrument with the initials “IA” for Iowa and an “Open Delta” as Mr. Rasty’s personal symbol. Mr. Rasty then began a series of experiments in order to establish whether or not the tattoo system would work in actual field conditions.
While it sounds simple, as it turned out, a number of problems had to be addressed and solved. Failure to solve any one of them would have doomed the program.

First of all we needed to know if the tattoo instrument was small enough to fit the space available on a new born or weener pig. It was. Mr. Rasty does his tattooing at three days old, or at the same time as docking, castrating and tooth clipping.

How time consuming was the process? We find that it takes just a few second for each pig.

Would the ear curl or atrophy due to the tiny puncture wounds made by the tattoo needles? The answer is “no.”

What happens to the legibility over the lifetime of the pig? Would the tattoo paste or ink be destroyed by the animal’s body chemistry? We found that black ink has a tendency to fade. Our specially formulated green paste was very legible throughout the life of the pig and through the slaughter process.

What about the warping of the tattoo due to uneven growth of the ear? We discovered that a pig’s ear has very uniform growth, certainly far more uniform than the hip of cattle, and a good tattoo at three days old would be a very legible tattoo in an adult pig. In fact, it’s very easy to read the tattoo of a grown pig across the distance of a pig pen.

What about cost? The only expense is the cost of a small hand-held tattoo plier and a supply of tattoo paste. We’ve found that a small tube of tattoo paste will be sufficient for several hundred pigs.

Mr. Rasty is very active in the Iowa Crime Prevention Coalition and when he was once satisfied that Pig I.D. Ear Tattooing could be technically successful, he wanted to explore the possibility of using the same system with a nationally registered 10 digit crime prevention number. Mr. Rutenbeck will discuss crime prevention in more detail, so I’ll limit my remarks to the instrument itself. By shaving away material from the standard needle blocks we were able to materially reduce the space needed to make a solid 10 digit block that would still be small enough to use with new born pigs.

This card illustrates the result and these are presently available.

Mr. Charles Rutenbeck, who is a Special Aid at the Iowa Attorney General’s Office in Des Moines, Iowa will now describe the excellent cooperation received from different groups and organizations who have an interest in this type of animal identification. He will also address the question of how Iowa is handling the ordering and distribution of the 10 digit instrument and the legal ramifications.
AUTOMATED IDENTIFICATION AND TEMPERATURE MONITORING IN FEMALE MAMMALS

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INTRODUCTION

The technology, now known as ZARTemp, began developing in 1974. The original goal was to test radio transmission of body temperature, i.e., remote sensing, as a means of detecting standing heat and febrile illness. A few studies dealing with rectal and vaginal temperature records indicated a high likelihood for success (Roark and Herman, 1950; Smirnova, 1954; Wrenn et al., 1958; Bane and Rajakoski, 1961; Kumaran and Iya, 1966; Valdivia and Vallenas, 1966; Sharma et al., 1968; K'nchev et al., 1974; Lira et al., 1975; Pau and Wan, 1976). Because it is unreasonable to think of taking repeated temperature readings by hand under commercial circumstances, remote sensing seemed to be a prerequisite to a satisfactory system.

The first transmitters used were produced by Mini-Mitter Co., Inc. Some had no identification capability and broadcast throughout most of the AM radio band. Others were crystal controlled in the FM band and could be used for up to six animals identified with one receiver. These transmitters were battery powered (active) and had a continuous decay rate with a life expectancy of about four months. Nevertheless, these transmitters enabled the validation of intra-abdominal and, later, intra-vaginal temperature recording as a means of tracing reproductive activity of cows, sows and mares (Zartman and DeAlba, 1982).

About 1977, lithium batteries became available. The highly stable and long-lived batteries made it possible to collect several years of data at a reasonable cost with a single transmitter. Believing this to be a substantial technological breakthrough, I began pursuing the next problem — automated identification of large numbers of animals in a group. Thanks to the expertise of Mr. Bob Wagner and Mr. Harold Shaw, engineers with the Physical Sciences Laboratory of New Mexico State University, a transmitter and antenna system with computerized data reception that met my needs was developed.

Four criteria were established as minimum characteristics of a practical system: (1) efficacy, (2) simplicity, (3) safe for the animal and (4) cost effective. The final link in the technology development necessary to satisfy these criteria was a non-surgical placement of the transmitter. The obvious site was the vagina. I had to invent a suitable anchor that would hold a

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1Mini-Mitter Co., Inc., P.O. Box 3386, Sunriver, OR 97702.
transmitter in the vagina, non-surgically, over a long time period. Once that was accomplished, the essence of the project was complete. At this point, two patents were issued (U.S. Patent Nos. 4,377,157 and 4,387,724), protecting the anchor design and the methodology of intravaginal temperature sensing by remote means.

MATERIALS AND METHODS

The transmitter and anchor (see Fig. 1 in Zartman et al., 1983) are placed in the vagina of a female mammal by collapsing the anchor fingers and sliding the assemblage through a tube speculum with a plunger until it exits the anterior end of the tube near the cervical wall of the vagina. The transmitter remains in place until removed, or until the act of parturition when it will be expelled with the fetus. Artificial insemination is accomplished without removing the transmitter, and a few animals have been bred naturally while wearing the transmitter.

The present transmitter configuration is capable of identifying up to 256 animals with one system. The signal rate is temperature dependent by means of a thermistor in the circuit. The signal is located in the AM radio band. Data can be collected with a hand-held system but, of course, the optimum system is computer driven. A 48 K-byte microprocessor with three floppy-disc drives has been employed as the data collection and processing machinery. The lithium battery powered transmitter lasts at least three years and is reusable.

The antenna design requires three concentric loops through which the animal walks at the time of data collection. Readings must be taken at least once per day at about the same time (± 1 hr) each day. I have found twice-a-day recording to be very efficient at identifying important temperature-related phenomena, but even once-a-day is quite satisfactory when the morning hours are used (ca 6:00). To recognize an important temperature change, the present-day reading must be at least 0.4°C above the average of the previous five days. In fact, the absolute temperature is not at issue but, rather, the change in temperature from day-to-day is the object of interpretation. An animal’s basal temperature is inconstant and not useful in terms of pegging a given value as the point of reference. Furthermore, individual animals have individual temperature characteristics, so each must be her own control.

RESULTS

As was shown by Nakamura et al. (1982) and Zartman et al. (1983), telemetry of vaginal temperature is a valid method for identifying ovulation days for dairy cattle. Because the dairy industry is urgently in need of this kind of methodology, efforts have been most concentrated in this area. The report by Zartman et al. (1983) shows the vaginal device has no effect on heifers’ physical activity or reproductive hormone patterns. Reproductive statistics were not significantly changed by the use of the vaginal devices.
An experiment on cows in production is now nearing completion. The experiment goal was to develop a management program based on automated identification and temperature data processing. Twenty recently freshened cows were randomly allocated to two equal groups—a control group or a transmitter group. Transmitters were implanted intravaginally at about the fiftieth day of lactation. Breedings and treatments were based on the computer output for the telemetry group, but were left to usual dairy management techniques for the control group.

In the telemetry group, one older cow was culled after a month because of recurring mastitis, coupled with a poor conformation. Her mastitis, when clinical, was always flagged by the computer. Also, two cases of cows with footrot were flagged and two cases of low-grade fever were detected in cows which appeared to be healthy. One cow in the control group died without warning. Telemetry might have avoided this unfortunate incident.

Failure to ovulate becomes obvious when a cow has no periodic temperature spike, which is characteristic of ovulation. That is, cystic cows can be identified early in their history. Four of the 10 cows in the telemetry group were so identified and were proven to have a retained corpus luteum problem because they all responded to prostaglandin F₂α treatment.

Two telemetry cows returned to standing heat after becoming pregnant. In fact, one cow did it twice. She later miscarried. The computer correctly analyzed these cases as not being ovulatory because the temperature did not change at those times.

At the end of nearly a year, all nine of the remaining telemetry cows are pregnant. Only seven of the nine remaining control cows are known to be pregnant. Services per conception were reduced from 2.3 on seven control cows to 2.0 on eight telemetry cows. The ninth telemetry cow was bred on eight occasions before becoming pregnant. Her temperature record showed incoordination between standing heat and ovulation by several days on most heats. The other three control cows which are not yet confirmed pregnant (one is now dead) have collectively received 18 services. Average days open on the telemetry cows was 148.4 for all nine (129.1 if the problem cow is excluded). For the control cows, if all are presently pregnant, the least they can have is 164 average days open.

The system's identification function is subjected to an auditing check in the computer software. If the identification does not repeat properly, it is rejected by the computer. Consequently, the incidence of improper data identification was slight, certainly less than 1%.

**FUTURE DEVELOPMENTS**

A new anchor, substantially different than the original patent, has already been invented and tested. It has the advantages of lower production cost, orientation control of the transmitter and moisture-proof transmitter encasement. Also, a delivery system has been invented which should preclude the need for sanitation of equipment or the cow.
The telemetry system is being re-engineered to operate from an FM range transmitter through a dipole antenna. This will permit virtually unlimited numbers of animals in a single system as long as the animals are brought to an antenna range, as is commonly done with milking cows. The system will be integrated into other dairy functions such as milk recording and feed distribution. The exact time of milking is to be recorded automatically when the cow is identified. This feature may be of great use in AM-PM testing.

SUMMARY

ZARTemp has automated identification of cows and automated processing of their temperature profiles. The results were fewer services per conception, a higher conception rate and fewer days open. Furthermore, all instances of febrile disease were detected. These features promise to improve dairy management significantly. The automated identification is attractive as an adjunct to other measurement and recordkeeping problems found in animal husbandry.

REFERENCES


REPORT OF COMMITTEE ON
LIVESTOCK IDENTIFICATION

Chairman: Harold Mindermann, West Des Moines, IA

Vice Chairman: R. E. Nelson, Brattleboro, VT

J. B. Ashcroft, CO; P. E. Bradshaw, IL; D. R. Bridgewater, CO; H. F. Embry, IL; G. B. Estes, VA; Robert Gadd, SD; Bill Gallagher, SD; H. E. Goldstein, OH; Tom Haas, KY; J. N. Huff, CO; G. M. Jones, NM; Ralph Jones, SD; Dee Likes, KS; Marlin Main, SD; N. F. Powers, Jr., NY; E. C. Roukema, VA; Raymond Schnell, ND; G. L. Seawright, NM; R. S. Sechrist, OH; G. R. Snyder, VA; W. E. Stemler, IL; F. E. Sterner, CO; J. R. Taylor, TX; J. E. Thomas, NV

Committee held its meeting Wednesday October 19 with the following members present:


Dr. Granville Frye reported the results of identifying boars with ear tags with trace book as a part of determining the feasibility of testing boars for Swine Brucelloses as sentinel animals in lieu of testing all sows. He reported 98 trace back attempts with 77.6% certain to herd of origin, 10.4% reasonably certain to herd of origin, 1% unlikely herd of origin and 1% herd of origin not located. The average time required for 69 traces was 2.44 hours each. Ten ID numbers were sent to Iowa with no names and 9 were traced without difficulty and 1 required the extra time. Most of the boars were slaughtered within three days.

Dr. Frye went on to discuss the project in Georgia that will extend for over two years with Stocker Shield Company making the tags. He noted a 93% recovery rate with improved glue in back tags attached off the midline.

In developing the recommendation of the Swine Brucellosis Subcommittee to eliminate the slap tattoo as an option for identification of boars at slaughter, Mr. Neal Black of Livestock Conservation Institute emphasized that it can not be read until the hair is removed, it can not be seen on the live hog to determine if it is tattooed (especially if colored) and when hogs are skinned, the tattoo is lost. He predicted that if 50% of the ear tagged boars from infected herds were infected the identification and location of infected herds will be greater than at present with very low percentage of trace back.

Dr. R.D. Whiting of USDA APHIS explained the new requirements for back tags including a vinyl backing to minimize curling, adding “sizing” or “wet strength” to the paper to reduce deterioration and use of yellow paper to increase readability.

Dr. Hugh Metcalf explained that bangle tags would be improved with lettering being more resistant to the effects of temperature and weather to
reduce fading. Flexibility of that part that pierces the ear will improve retention.

He went on to explain that tube glue approved for FY84 is the same as last year (same successful bidder). There is only one approved source of glue in other containers for FY84, but two manufacturers were submitting new products for approval in other containers for possible use in FY85.

Of particular interest was the report that more precise specifications with revisions for producing metal ear tags were laid down for FY84 with thickness increased from .035 inches to .042 inches and they would be coated with rust inhibitor. In addition the spacing between letters and digits and size of digits was specified in order to increase readability. Also there were set forth the minimum and maximum for dimensions of the tag and size of the opening. However the depth of the cut of the letters and digits was not addressed, but the possible need was recognized. In addition it is now specified that the holder on which the tags are shipped must retain the tags in numerical sequence as tags are used. A suggestion that a wider tag be considered was noted.

Dr. Robert E. Wagner, USDA-APHIS, reviewed the progress in responding to 1982 committee action on examining part of 71.18. It proposes specifying federal offense for removing or tampering with the ear tag of an animal at any time during its movement from farm of origin to final destination. He pointed out that a dealer may not come under the jurisdiction of the code as now written with respect to his handling of animals in transit once the animals are on his premises though they were destined for other locations. It was indicated that the use of the words “interstate commerce” were substituted for “interstate movement” and included those who sell the animal either as owner or agent in the prohibiting statement. Such changes would require other revisions in title 9 CFR and a draft copy was not yet available. This prompted the Committee to act to meet next spring in extra session to review the proposal in keeping with the motion made by Dr. Goldstein.

*In addition the Committee reaffirmed its 82 action recommendation that the UM&R for Brucellosis Eradication and Control include a requirement that each state tampering with or removing official identification with this recommendation to be presented directly to the Executive Committee.

The Committee acted to request APHIS to investigate and field test the bar coding of back tags and identify the equipment needed to read and record the codes with the results of the test reported at the spring meeting of the Committee.

Mr. David Stone, President of Stone Manufacturing Company of Kansas City, Missouri explained the system of tattooing baby pigs with a miniature tattooing device with 10 digits of identification that permit tracing a unique number to the herd of origin. This was followed by an explanation of the application of this system to theft control in Iowa by Charles Rutenbeck, Special Aid to the Iowa Attorney General. He explained that
this identification system fit in with the use of a state issued crime control number. He identified several types of situations when this identification was beneficial and served the owner well along with serving well in disease eradication and control and in residue trace back with accuracy.

The Committee than acted on Motion of Mr. Bradshaw to recognize the merit of this system of identification for swine and commended it for use by other states.

It was then pointed out by Dr. Dewey Bond that the American Meat Institute was asking complete identification of all animals presented for slaughter. It was also pointed out that swine producers, according to a National Pork Producers Council survey, were 85% to 90% in favor of identification.

In the area of Electronic Identification, Dr. David Zartman of New Mexico State University explained a system being commercialized that involved implanting a device in the vagina to detect ovulation and onset of disease through automated electronically temperature monitoring. Mr. Cliff Prough of Identification Devices Inc. updated the Committee on the progress since last year with a demonstration of reading out a 10 digit number from a pinhead size identifying unit with a hand held interrogator.

Richard Nelson summarized other electronic identification activity around the world and the President of the International Brands Conference expressed the interest of that group in the activity of this Committee.

On matters of specific action the Committee:

1. Supports the recommendation of the Swine Brucellosis Subcommittee that the slap tattoo be eliminated as an option for identification of boars in slaughter.

2. Hold an extra meeting in the spring, probably at the time of the LCI Annual Meeting, to review any aspects of identification as well as to review proposed revisions in part 78.18.

3. Commend the Iowa System of Identifying swine to the consideration by other states.

4. Request APHIS to investigate the use of bar coding back tags implement a field trial and report the results of the field trial at the spring meeting.

* 5. Reemphasize the 1982 action to include in the UM&R a prohibition against removing or tampering with any identification.

*Committee report accepted with the deletion of paragraphs in brackets.
Anyone who would sense the future must first take a long look at the past. We can anticipate how today's actions will affect a distant future only if we understand how events in the past have brought us to the present.

In the field of animal health, we look back to one particular landmark, from which we measure many of our achievements. Nearly one-hundred years ago, Congress established the Bureau of Animal Industry, the old BAI, as it was known. This Act firmly committed the Government to the goal of controlling and eradicating animal diseases. And in implementing that goal, the BAI developed and refined the concept of cooperative State-Federal agreements; under these agreements, many disease eradication programs were established and carried to completion. Under this same cooperative approach, we continue to move forward toward the goals remaining before us.

All of this came into being largely because of two highly visible livestock diseases, contagious bovine pleuropneumonia and Texas fever. These and later programs had one thing in common. They were in response to problems that were too big to be ignored.

The legacy of the BAI, which is our heritage, is that the agency found and eradicated epizootic diseases.

Today, major epizootics have largely been eliminated from this country. Should any of them recur, we will respond with a total emergency animal disease eradication effort. We continue to guard against these diseases. And we maintain the epidemiology and surveillance that have served us so well.

In spite of our achievements, the livestock industry continues to bear substantial losses because of other diseases and animal health problems, the less obvious ones. In the more developed countries, production can be reduced by 20 percent because of these less apparent problems. In Third World countries, livestock diseases can account for a 40 percent decrease in production.

What can or should we do about the costs of disease? Even if there are no persistent plagues or raging epizootics, shouldn't we know more about the total picture of livestock and poultry health in the United States? Isn't it time to address long-standing concerns for the less apparent, as well as the major, animal health problems in our herds and flocks?

It is out of concern for this total health picture, that this year we are starting a new program, the National Animal Disease Surveillance system, or "NADS." USDA's Animal and Plant Health Inspection Service (APHIS) will be the lead agency in a comprehensive effort to develop methodology for securing information on disease prevalence, incidence,
trends and economic costs. We will be working in cooperation with other USDA agencies, such as the Agricultural Research Service (ARS), the Statistical Reporting Service (SRS), the Food Safety and Inspection Service (FSIS), and the Extension Service (ES).

We will need the support of other groups and agencies as well—the State departments of agriculture, diagnostic laboratories, practicing veterinarians, colleges of veterinary medicine, and livestock owners and their associations. NADS must reflect an interdisciplinary approach involving knowledge of preventive medicine, epidemiology, management, economics, and statistical analysis—as well as diagnostic veterinary medicine.

The development of this system will require several years. As we get started, the National Animal Disease Surveillance system will develop in the following way.

Initially it will be built on the experience of pilot projects in several States. Ohio and Tennessee are designated as the first pilot States in this effort. In September, we started in these States with training programs for Federal, State, and university veterinarians who will provide surveillance, working directly with a representative sampling of livestock owners. Training includes (1) interviewing skills; (2) collection of data in an objective manner; (3) personal relationships and communications; (4) recognition of the principal conditions and diseases in various types of livestock; and (5) assessment of the economic impact of these diseases.

Data will be collected from participating farm cooperators who have been selected by random sampling. A statistically significant subsample will also be needed to make more precise, laboratory-based assessments on the specific causality of diseases. More sophisticated computer-assisted programs and modeling are expected to follow.

All of this will take several years, with additional experience being gained as we add pilot projects in other States and refine methodology. It is essential that we assure the collection of high-quality data, since computer-generated information will be only as valid as the basic data provided.

This is not a traditional "regulatory" program. But it is very much the business of animal health. APHIS Veterinary Services will function as the coordinator and facilitator in an integrated effort to get ahead of the problems. This effort will include animal health agencies, the veterinary profession, and the agricultural industry. When we have refined the methodology, programmed the assembly of information, and disseminated the results, we will have a surveillance program that gives a complete picture of animal health in the United States.

Having described, at this early stage, what we hope to do, let me back up and summarize the needs that impelled us to begin this effort. These were not just the needs of a public animal health agency, but the needs of many groups and individuals.

I have already mentioned the need to know more about the total animal disease picture, rather than waiting until problems are too big to be
ignored. This is a valid concern.

In today's agriculture, new emerging diseases challenge our capabilities. New production systems, marketing practices, and intensive animal husbandry increase the costliness and potential destructiveness of diseases and health problems. Environmental, genetic, and production factors create a new milieu for diseases.

We now recognize diseases as complex syndromes that require more sophisticated diagnostic techniques. We need to collect significant data about modern disease conditions. And we need new techniques for evaluating the causes, interactions, and economic consequences of these diseases on a national level.

Herd health management is increasingly the basis for livestock production. In order to make rational decisions on herd health strategies, a manager must know about disease prevalence, incidence, geographical and seasonal aspects, anticipated losses, and various control alternatives, their costs and effectiveness. He must know the economic advantages of changing management systems, or of initiating certain treatments.

And herd health management is no longer necessarily under a single manager. The livestock industry is increasingly intensive and complex. It has undergone tremendous changes in the past few decades. This has resulted in mobile populations, vertical structures, and specialty groupings. Certain industries consist of unique subpopulations, subject to rapid, large-volume movements and concentrations in specific geographic areas.

This production environment demands costly decisions, which must be based on comprehensive knowledge of the conditions to be faced. Unfortunately, much of that information is not available in the overall area of animal diseases.

In the meantime, the base of scientific and technical information is expanding. It is estimated that scientific information increases 13 percent per year and doubles approximately every 5 years. In the future, this deluge of scientific information could increase by 40 percent annually and double every 20 months. This knowledge has the potential for revolutionizing agriculture, but to do so it must include the valid measurement of the health and disease situation in our animal industry.

Along with the scientific revolution, there is an economic evolution. We are changing from a national to a global economy—restructuring from a narrow, "either-or" outlook to a multiple-option system. The management of production, processing, and distribution systems is more and more tied up with international influences. And the decisions that are made on these systems are in turn tied up with the national and international assembling and processing of information.

And the assembly, storage, and retrieval of information is itself in a state of revolution, or evolution. We are currently in the midst of an information explosion. The livestock industry and the animal health fields are not exempt from the impact of what is now being called an "info-
In the midst of the scientific-information explosion and economic complexities, we face some constraints. Research administrators need knowledge of the incidence and economic burden of certain diseases if they are to assign priorities properly. Researchers need that knowledge if they are to develop and justify grant proposals. In the midst of the explosion, we need to know where we are going.

Perhaps it is a bit much at this stage to project NADs into an international concept. But it is not hard to see what NADs can do if we simply look at the individuals who work in the animal health field and in the livestock industry.

The livestock owner or manager is responsible for a herd health plan. Whether he develops a highly sophisticated, scientific plan, or operates on a practical “seat-of-the-pants” plan he needs precise information on the conditions facing him. A minor disease can still cause major problems, if it is his animals that have it. NADs should identify the impact of the minor diseases, as well as the major ones.

The veterinary practitioner, who is often the chief architect of the herd health plan, needs to know what diseases are prevalent, increasing, or decreasing in his area—or what diseases are of concern in the area where his client is buying livestock. He is highly dependent on other sources for the total picture of livestock health conditions. NADs is such a source.

Pharmaceutical and biological companies need information on disease trends and infection rates, if they are to plan and develop research and marketing strategies for future products. The drug industry—and its users—will be principal beneficiaries of NADS.

The research scientist ideally should be ahead of future health problems, if he is to provide the most effective answers. And new studies must be based on sound justification, if the right priorities are to be assigned. Information generated by NADs can provide a foundation for such priorities and planning.

Veterinary medical students and others in universities can benefit from the fund of knowledge obtained from NADS, especially for training in the increasingly important concepts of herd health management and preventive veterinary medicine. It can help in the continuing education of such professionals after graduation.

And finally, the State and Federal officials responsible for regulatory veterinary medicine need a complete picture upon which to plan programs and approach legislators. Sound disease information can determine whether action on our part is needed, or whether it is feasible. It can set the economic cost-benefit basis for proceeding or holding back, and provide better understanding with the industry. And it can strengthen our ability to monitor an incursion of a foreign animal disease.

The picture I have painted is being realistically tested, and the National Animal Disease Surveillance system is underway. The future calls for
better herd management, for stronger animal health programs, and for more complete knowledge in all areas.

You will be hearing more of the acronym, "N-A-D-S." The partnership we have known in the past—with Federal, State and industry participants—will be strengthened as we develop solid information on our Nation's animal health. Pilot projects will be initiated in additional States. Computer-assisted programs and modeling will be developed. Within the next few years, "surveillance" will have assumed new significance.

A sense of the future does not deal with future decisions, but rather with the future of present decisions. Today's budgetary realities necessitate the most cost-effective use of public funds. NADS will serve our program commitments; at the same time, it will help many people who, acting alone, could not obtain such information. With NADS-generated information, both we in the cooperative programs and many individuals will have a sound basis for decisions—present and future.

The NADS system is consistent with the APHIS mission, which is to protect the animal and plant resources of the Nation from diseases and pests. Beyond this, and as a direct result, we protect the marketability of our agricultural products, here in the United States and for export. At the same time, NADS presents a new concept of our responsiveness to this public mandate. In a fundamentally new approach, we will be offering a capability for preventing—heading off—diseases, as well as controlling and eradicating them.

In a world full of dramatic changes, it would be more comfortable to continue in the old ways, good and effective as they were. It is questionable whether we could for long, even if we wanted to, without being overwhelmed. NADS is a recommitment to our mission, to the public and to the agricultural community.

John Steinbeck said, "It is the nature of a man as he grows older to protest against change, particularly change for the better." I hope our sense of the future precludes us from that approach. The heritage of the BAI is now a hundred years old, old enough to be comfortable and resistant to change. But as heirs of that dynamic agency, we are capable of becoming better. I look forward to the development and realization of the National Animal Disease Surveillance system.
In September of this year, State and Federal Veterinary Medical Officers (VMO's) from Ohio and Tennessee and two university veterinarians (Ohio State University and the University of Tennessee) were involved in training activities to kick off the Animal and Plant Health Inspection Service (APHIS) pilot project for National Animal Disease Surveillance (NADS). This represents the beginning of the next stage of the APHIS five-phase program for NADS that was introduced at the USAHA meeting in 1981 and unanimously supported by this committee.

This is a major step which takes NADS off the "drawing board" and into the realities for which it must be tested. The NADS system is moving ahead in its plan to develop the methodology for assessing incidence, prevalence, trends, and the economic impact of diseases of domestic livestock. The project is concerned with valid data collection and its unbiased interpretation. Surveillance based on statistically sound requirements and random selection of herds allows for valid estimates and inferences to be made for entire populations at risk.

In the pilot States, surveillance will be limited to beef cattle, dairy cattle, and hog operations. Farms are randomly selected and stratified by size and production unit through the use of the Statistical Reporting Service's (SRS) frequency distribution tables and the use of lists supplied by county extension agents. Each participating livestock producer, who will be used for a period of 15 months, will be paid $25 a month for his services. The field veterinarian will visit each of his four assigned farmsteads on a monthly basis. The veterinarian and farm cooperator will closely monitor the selected herds and help account for all disease occurrences and economic costs associated with the disease conditions.

Forms have been designed for enumerating and analyzing pertinent data. The VMO and livestock cooperator will assess the herd health status and give clinical impressions of disease and health related conditions. Once this broad-range health assessment is done, a statistically significant subsample will be needed for making more precise, laboratory confirmed diagnoses to define specific disease causes. There are, of course, diseases which result in subclinical or inapparent infections. As we learn more about these disease entities, it is apparent that such infections may actually result in economic losses which have not been previously considered. Therefore, indepth diagnostic workups involving the diagnostic laboratories are essential and are seen as playing a vital role in this activity. The formation of a national serum bank is also envisioned as a worthwhile effort in a NADS system.

In many instances, herds selected for surveillance activities will be serviced by private practitioners. The VMO will work closely with the
veterinary practitioner to help assess an accurate herd health picture. The VMO's who collect the data will never function as, or supplant, the private practitioner. When treatments or services are needed or requested, the VMO will always recommend the use of a local practitioner.

It will be necessary to continuously refine the methodology for collecting and analysing the on-farm data. We anticipate several years of work and the addition of more States into the pilot program before meaningful data can be generated. In FY '84, three additional States will be included in the project. In FY '85, we may double this effort. It is mandatory to assure that high-quality and unbiased data are collected before the use of either computer-generated information or sophisticated techniques such as modelling is considered; however, the use of such technology is seen as an important future objective.

Close and continuous contact with the 25 veterinarians collecting the on-farm data is an essential function. Evaluation meetings will be held in Ohio and Tennessee after 2 to 3 months’ data have been collected. These ongoing evaluations will help refine our methodology. The forms coming from the field will be closely examined by Federal, State, and university personnel. The pilot project is a learning experience for everyone, and many changes will be made as we design a workable system.

The need for a statistically reliable national animal disease system has never been greater. In the past the livestock diseases of concern have been the highly visible, major epizootics. The prevalence of many of these diseases has been substantially reduced or eliminated; yet, despite these advances, production losses have remained high. New, emerging diseases are on the horizon. Modern production and marketing practices, and intensive methods of animal husbandry may be responsible for an increase in animal diseases due to environmental and genetic factors. Diseases are being recognized as very complex syndromes that require more sophisticated diagnostic techniques and also require us to collect significant data to learn about these diseases. We must utilize new techniques to collect and evaluate data and assess disease prevalence, trends, and economic losses on a State, regional and national level. Effective control of animal diseases can be achieved only by basing decisions and programs on accurate up-to-date information, which is currently unavailable.

An effective system of animal health surveillance will require information to be gleaned from the collection of statistically and scientifically valid data. This will allow the livestock industry to accurately define its disease problems and their economic significance. Partial or complete elimination of these losses will increase the quality and supply of animal protein, reduce their cost to the consumer, conserve energy resources, and increase export potential.

Current data on animal diseases are fragmented, nonadditive, and not statistically valid. This situation is unacceptable for a nation whose livestock industry produces food and fiber second to none. The cost of animal diseases to producers has been estimated to be between $4 and $6
billion annually. However, in truth, without a statistically reliable national animal disease surveillance system, no one can know for certain.

There would appear to be little disagreement as to what information is needed, but the methodology to secure this information is more controversial. Historically, several unsuccessful attempts have been made to acquire basic information on implementing a NADS system. Hopefully, we can learn from past mistakes; those previous experiences will be helpful in developing a new NADS system.

APHIS has been designated as the lead agency to develop methodology which will provide estimates on disease prevalence, incidence, trends, and economic costs. To be successful in this endeavor, we will need the cooperation of other government agencies, such as the Agricultural Research Service, the Statistical Reporting Service, the Food Safety and Inspection Service, and the Extension Service. The support of other groups is also essential, such as: State departments of agriculture, diagnostic laboratories, practicing veterinarians, colleges of veterinary medicine, and especially livestock owners and their associations. APHIS intends its role in a NADS system to be one of a coordinator and facilitator of an integrated effort, which will be based on the cooperation between many veterinary and agribusiness professions. Consultants and advisors also are necessary. A liaison council which will include members of the livestock industry and veterinary specialists will be implemented soon. Appropriate seminars will be held with all cooperating groups in order to explain the NADS system.

Today's budgetary realities necessitate the most cost-effective use of public funds: The more that is known about animal diseases, the better State and Federal agencies can plan their programs. A NADS system will allow APHIS to accommodate many potential beneficiaries who, by themselves, cannot collaborate and marshal resources on a national basis.

As we expand the pilot project and develop the proper methodology to reach our objectives, we will be calling on many groups for input and assistance, including members of this committee. Mistakes will be made, and we acknowledge that many questions remain unanswered at this time. However, it is time to move ahead and leave the academic arguments and any self-serving special interests behind us. We must have a visionary outlook, yet be practical and perceptive in our methods and carefully scrutinize our implementation plans for a NADS system. There are many people looking over our shoulder, and the contribution of this committee will be reflected in planning future events.
PERSPECTIVES ON ANIMAL DISEASE SURVEILLANCE
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Veterinary Services (VS) of the Animal and Plant Health Inspection Service (APHIS), United States Department of Agriculture (USDA), and its predecessor organizations together with various cooperating state agencies have been involved in animal disease reporting and surveillance for many years. Considerable interest has been expressed and much effort has been expended in the past in examining the nature of animal disease surveillance information and in developing plans for improving this information.

In light of recent activities which have been directed towards the development of a statistically valid National Animal Disease Surveillance (NADS) system (McCallon, 1981a and 1981b; Poppensiek, et al, 1981; and McCallon and Beal, 1982a), it is advisable to review this past interest and effort. It is also advisable to examine the meaning of animal disease surveillance from various perspectives and to review various aspects of the information generated by animal disease surveillance activities.

REASONS FOR ANIMAL DISEASE SURVEILLANCE

Past interest and efforts in animal disease surveillance have been influenced by the perspective of the various workers involved. They have also been influenced by the fact that the purpose of animal disease surveillance is different for diverse individuals and groups.

The various needs or reasons for animal disease surveillance information fall into two general groups. One group involves statistically based requirements and the other involves non-statistically based requirements.

The statistically based requirements include (1) estimates of prevalence or incidence, (2) estimates of trend, and (3) estimates of physical and hence economic loss. The non-statistically based requirements include (1) foreign disease detection, (2) certification for interstate or export shipment, (3) certification of States, counties, or local areas, (4) certification of herds, (5) emerging disease alert or rare disease information, (6) cyclical disease alert of vaccination planning, etc, and (7) laboratory management.

EARLY EFFORTS AND INTEREST

Much of the early interest and effort appears to have focused to a large degree upon statistically based needs for information. Much of this early interest and effort was stimulated by the efforts of past committees (Schroeder, et al, 1945, 1946, 1947 and 1948) of the United States Livestock Sanitary Association (USLSA) which was the predecessor organization of the United States Animal Health Association (USAHA).

This interest and past effort was manifested in the various USLSA committee reports. Also, the 1945 USLSA report mentioned efforts of the
American Veterinary Medical Association in this area and the 1946 report mentioned efforts by the National Research Council (NRC) of the National Academy of Sciences (NAS). These two reports also offered suggestions directed towards obtaining improved information.

Implicit in these reports from the USLSA was the concept of requiring statistically reliable information. This concept was reflected in the 1945 report which stated that there was no source of authoritative data on either morbidity or mortality statistics of miscellaneous livestock diseases. Further, there was mention of not being able to obtain the number of outbreaks, deaths, and the disease incidence from a single state and of the need for unbiased vital statistics (Schroeder, et al, 1945).

This concept of statistically reliable information was also reflected in the 1946 report in reiterating statements from the 1945 report and in referring to "... surveys on livestock losses and economics of morbidity established by the Committee on Veterinary Services for Farm Animals," of the NRC (Schroeder, et al, 1946). This concept was further reflected in the 1947 report (Schroeder, et al, 1947) with mention of an experiment in Iowa which was described in two reports in the proceedings of that year (Newton, 1947; and Snedecor, 1947).

TRADITIONAL ANIMAL DISEASE REPORTING SYSTEMS IN THE UNITED STATES

While there had been earlier interest in vital statistics for animal diseases as described in a review by Poppensiek and Budd (1966), these earlier efforts did not bear fruition. As a result of the subsequent efforts on the part of the USLSA, plans on animal morbidity and mortality reporting were presented at the 58th annual meeting in 1954 (Clarkson, 1954). Most of these plans were subsequently implemented and the USLSA committee went out of existence following the 60th annual meeting of USLSA in 1956 with the feeling that it had accomplished its goal (Hay, 1956).

The resulting systems and reports might be regarded as constituting the traditional animal disease reporting system which has been common in many countries (McCallon and Beal, 1982a). Procedures for these reports were described by Hourrigan (1958 and 1959).

The National Report of Animal Diseases: As a result of this effort on the part of USLSA, VS coordinated a national disease reporting system for a number of years. This was the National Report on Animal Diseases (NRAD). The system generally consisted of a small and variable number of practicing veterinarians in most states reporting the diseases they thought they had seen in the course of their practice the preceding month.

In most states, this information was obtained by practitioners completing and returning questionnaires which had been mailed to them monthly by the State Veterinarian. In some states, this was augmented or replaced by data from state diagnostic laboratories and/or veterinary school clinics. This report was discontinued in 1972 for reasons discussed later.
ANIMAL DISEASE SURVEILLANCE

The National Animal Morbidity Report: The NRAD was supplemented by two other reports. One was the National Animal Morbidity report (NAMR). In general, the NAMR covered control program diseases such as brucellosis and psoroptic scabies and diseases ancillary to these such as paratuberculosis and chorioptic scabies. However, it included some other diseases, also covered in the NRAD, such as rabies and anthrax. All program diseases were also included in the NRAD. This report was discontinued in 1981.

The Consolidated Report of Animal Diseases at Public Stockyards: The NRAD was also supplemented by the Consolidated Report of Animal Diseases at the Public Stockyards (RADPS). The RADPS covered conditions that were observed at public stockyards. This report was discontinued about 1972 when the inspection of livestock at terminal stockyards by Veterinary Medical Officers (VMO's) was discontinued due to the demise of the public stockyard as a major factor in the marketing of livestock.

Three Reports Make Up Traditional System: It was the responsibility of the VS Veterinarian in Charge in each state to compile the NRAD information and send it to national headquarters where the data were compiled on a state-by-state basis. After this was done, a summary of the NRAD, giving national totals, was distributed. The NAMR was compiled giving state as well as national totals and then distributed. The RADPS was compiled on a national basis. Such a reporting system is the traditional one used by nearly every country in the world.

REVIEWS OF THE TRADITIONAL ANIMAL DISEASE INFORMATION SYSTEM

Soon after the NRAD was implemented, problems with the report became evident to a number of observers. For instance, it was noted by Van Houweling (1960) that the report showed the occurrence of brucellosis to be twice that of mastitis and that the reverse was closer to the truth.

The need for surveys was addressed by Hourrigan (1962) soon after this observation. It is interesting that even as the NRAD was being implemented, Robson and Baker (1957) proposed that random sample surveys be conducted in order to determine incidence. This proposal must have come about in part because the data from the NRAD did not have a known denominator in order to estimate incidence and prevalence.

Problems were also noted with regard to the poor return rate from questionnaires and that a random sample of farmsteads similar to one which had been conducted in Great Britain (Leech, et al, 1960) would be an improvement (Beal, 1963b). There soon followed an extensive review by the NAS and a more limited review within VS.

National Academy of Science Review: An in-depth review of the history of morbidity and mortality reporting was performed under the auspices of the National Academy of Science (Poppensiek and Budd, ibid; and Scholtens, 1966). This review by NAS was quite thorough in terms of
reporting what had been done and what was the then current status in the United States. The review by Poppensiek and Budd was very extensive.

**Veterinary Services Review:** As a result of a second review inside of VS prior to the start of FY-73, the NRAD was discontinued in 1972 (McCallon and Beal, 1982a). This review followed two surveys, one on trichina in garbage fed swine (Jeffries, et al, 1966) and another on salmonella in feed mills (Allred, et al, 1967), which were very revealing.

It was evident that the traditional system could not reveal anything concerning disease prevalence or economic significance for any area of the country. Also, disease trends could not be estimated with any degree of confidence.

The inability of the traditional system to provide anything concerning disease prevalence or economic significance had become critical since this information was needed in performing cost-benefit analyses of existing or proposed programs. Also, many individuals and firms were requesting information from VS regarding the number of cases of certain diseases that were being reported. The agency was reluctant to tell them that only a few cases had been reported when it was known that this was probably only a fraction of what had really occurred.

In view of the above factors, it was concluded that the NRAD reporting system was providing little, if any, useful information, and it was, in fact, misleading. Consequently, the decision was made to discontinue it.

**REVIEWS OF WAYS TO IMPROVE ANIMAL DISEASE INFORMATION**

In view of the inadequacies in existing systems, it was obvious that there was a need to obtain better information. As implied above, regulatory agencies and research institutions were in need of accurate information concerning disease prevalence, incidence, trends, and economic losses in order to plan their research activities and regulatory programs.

The Office of Management and Budget (OMB) of the U.S. Government and the U.S. Congress have insisted on economic analyses in their allocation of funds. The above-mentioned cost-benefit analyses have been required in the USDA since 1966 (Beal, 1980a). Such analyses demand accurate information as to prevalence, incidence, trend, and economic loss for a disease.

Drug and biologics producers also need this type of information. In addition, meat and milk producers need information concerning the economically significant diseases in their area, how various management practices affect these diseases, and the most cost effective means to prevent or control them. Most of this needed information is not presently available.

**National Academy of Science Study:** As a result of the above-mentioned NAS review and of the need for valid data for cost-benefit analyses, many thought that a study was needed on whether the traditional system of morbidity and mortality reporting could be improved or if it should be replaced so as to have a system which would provide valid
data concerning disease prevalence and economic losses. Consequently, a study group was formed in 1969 under the auspices of the NAS (Hutton and Halvorson, 1974).

Unfortunately, this study failed to examine the adequacy of how various sources of information could fulfill the various needs for information (Beal, 1980b). This failure resulted from there being four schools of thought on how to collect information and on what was needed to fulfill the existing needs (McCallon, 1981b; McCallon and Beal, 1982a). These four schools of thought consisted of (1) the traditionalists, (2) the laboratory school, (3) the lumpers, and (4) the statisticians.

The "Traditionalists" thought that VS should continue the old reporting system and try to improve it by getting more veterinarians to report (Hutton, 1971). By doing this, perhaps some insight could be gained concerning disease losses and trends and it would at least be known whether or not a disease existed in the country.

The "Laboratory School" felt that only laboratory test results should be collected (Hutton, ibid). By doing this, there would be more certainty of the diagnosis, so the validity of the data would be much greater.

The "Lumpers" wanted to continue the traditional reporting system, collect laboratory test results, meat inspection records, and data from many other sources (Hutton, ibid). By doing this, one would accumulate a large amount of data with all possible data being included.

Critics of the above three schools of thought had several points of disagreement. It was pointed out that no matter how many veterinarians reported, a system based upon this type of reporting would not reveal any valid information concerning prevalence of diseases and economic losses (Harper et al, 1977). Additionally, it was pointed out that diagnosis from the reports was in doubt, as it was usually not based on laboratory backup and was often based on memory.

The problem with laboratory data is that there would still be nothing known about disease prevalence, economic losses, or if a disease existed in the country when no positive laboratory test had been obtained (Harper, ibid). In addition, there have been reports of a relationship between distance from a laboratory and frequency of submission. Also, once a practitioner has become familiar with a particular disease entity, he will submit fewer specimens to a laboratory. However, it was conceded that in those cases where positive tests were disclosed, there would be more confidence as to the existence of the disease than when a practitioner reported he had encountered the disease.

The lumping of all sources of data would serve to confuse the subject. There would be no valid information concerning disease prevalence or economic losses in this case and there would be no significant improvement over the laboratory system concerning whether or not a disease existed (Harper, ibid).

The "Statisticians" felt the only way prevalence, trends, or losses could
be estimated or to ascertain if a disease existed would be to conduct a statistically sound survey using a diagnostic method of high accuracy (Beal and Cox 1970; Cox and Huddleston 1971). Their critics pointed out that it would be much too costly to do this for a great number of diseases so, in effect, they were offering no feasible proposal for a reporting and surveillance system.

**Problems of Invalid or Misleading Data:** This viewpoint on valid data is reflected by certain invalid inferences arising from the old NRAD system which has been mentioned earlier. As mentioned above, the data were compiled from reports which were submitted from individual States. Various problems with biased data have been discussed (McCallon and Beal 1982b). Problems with misleading data from control or eradication programs will be discussed later.

It has been mentioned above that data from the old NRAD had an unknown denominator. Arkansas would report anywhere between 18 and 45 percent for an average of 36 percent of the cases reported in the nation for anaplasmosis while California would report under one percent of the cases.

However, a probability sample survey of brucellosis market samples conducted for anaplasmosis showed a completely different situation. Table 1 (Beal, 1980b) provides a picture of the difference between the old NRAD and the probability sample survey in regard to the anaplasmosis picture for seven States.

This table gives the relative distribution of anaplasmosis in seven selected States with the average number of cases per year for fiscal years 1968 through 1972 from the old NRAD and with the estimated number of reactor animals and reactor rate from the probability sample survey of market cattle samples.

<table>
<thead>
<tr>
<th>Location</th>
<th>NRAD Ave. No. Cases/Per Fiscal Yr.</th>
<th>Probability Survey Estimate of Reactors in 1,000's</th>
<th>Percent Reactors</th>
<th>Percent of Infection in United States</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>7,136</td>
<td>5,640</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Arkansas</td>
<td>2,597</td>
<td>297</td>
<td>22</td>
<td>36.4</td>
</tr>
<tr>
<td>California</td>
<td>48</td>
<td>588</td>
<td>31</td>
<td>0.7</td>
</tr>
<tr>
<td>Louisiana</td>
<td>1,011</td>
<td>240</td>
<td>23</td>
<td>14.2</td>
</tr>
<tr>
<td>Mississippi</td>
<td>139</td>
<td>364</td>
<td>23</td>
<td>1.9</td>
</tr>
<tr>
<td>Missouri</td>
<td>155</td>
<td>368</td>
<td>12</td>
<td>2.1</td>
</tr>
<tr>
<td>Oregon</td>
<td>136</td>
<td>92</td>
<td>13</td>
<td>1.9</td>
</tr>
<tr>
<td>Texas</td>
<td>809</td>
<td>1,086</td>
<td>15</td>
<td>11.3</td>
</tr>
</tbody>
</table>

Where Arkansas had been reporting over 36 percent and California had been reporting less than one percent of the anaplasmosis for the United States in the old NRAD, the survey revealed 5.3 percent for Arkansas and
10.4 percent for California. It can be seen that similar discrepancies were found for the other high prevalence states with little relationship between the true incidence of anaplasmosis as shown by the probability sample survey and the biased picture as shown by the old NRAD.

A similar situation existed for equine infectious anemia (EIA). In FY'68, the state of Arkansas had 220 of the 453 cases reported for the United States. However, results of regulatory testing indicated that Arkansas may have around 10 percent rather than about 50 percent of the nation's EIA. These results for anaplasmosis and EIA served to confirm the wisdom of the earlier decision to discontinue the NRAD in 1972 because it was felt to be inadequate.

**Veterinary Services Study of 1976-1977:** As a result of the United States entry into the Organization of International Epizootics and of the failure of the 1974 NAS study to specify alternatives, VS embarked on yet another study of possible ways to improve animal disease information in 1976 (Harper 1977).

Where the NAS study failed to examine the various sources of information in terms of validity, this study proceeded to do so. This study also provided estimates of the costs of various alternatives. The validity of various types of information has also been examined by Leech and Sellers (1979) and will be examined below.

**RELATIONSHIP BETWEEN THE NEEDS FOR INFORMATION AND POTENTIAL SOURCES**

As can be seen, a number of groups and individuals have studied the problem of improving the existing animal disease information over the past 20 years or so and in every case, there has been little agreement as to what should be done. When one school of thought had the majority membership in the committee, the report tended to reflect that viewpoint.

It has appeared that part of the failure to arrive at a consensus on how to improve animal disease information has been due to a failure to examine the reasons for having animal disease information and how these reasons relate to the possible sources of information.

**USES FOR ANIMAL DISEASE INFORMATION**

It has been mentioned above that the reasons for animal disease surveillance information can be regarded as falling into two general groups which are statistically based requirements and non-statistically based requirements. These requirements are illustrated in Figures 1 and 2.

As stated previously, the statistically based information requirements include (1) estimates of prevalence or incidence, (2) estimates of trend, and (3) estimates of physical and hence economic loss as illustrated in Figure 1. The non-statistically based information requirements include (1) foreign disease detection, (2) certification for interstate or export shipment, (3) certification of states, counties, or local areas, (4) certification of herds, (5) emerging disease alert or rare disease information, (6) cyclical disease
alert for vaccination planning, etc, and (7) laboratory management as illustrated in Figure 2.

**Statistically Based Requirements:** Statistically based requirements refer to those needs for which information should be obtained from either probability sample surveys or from a complete census of the population. This results in there being a known population at risk or a denominator. Consequently, this information can be extrapolated to the entire population of interest. Figure 1 illustrates the categories of statistically based data that are required and the areas in which the information is required.

There are three categories of statistically based data that are required for the evaluation of the effect of animal diseases. They are (1) estimates of prevalence or incidence, (2) estimates of trend, and (3) estimates of physical and hence economic loss. This information is required in several areas.

**Figure 1. Statistically Based Uses for Animal Disease Information.**

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**A. Categories of Statistically Based Data.**

1. Estimates of prevalence or incidence.
2. Estimates of trend.
3. Estimates of physical and hence economic loss.

**B. Uses for Statistically Based Data.**

1. Control or eradication programs,
   a. Justify or reject program including Cost-Benefit analyses,
   b. Planning for new programs, and
   c. Program evaluation or management.
2. Research programs,
   a. Project justification or rejection, and
   b. Research planning.
3. Biologics or drug firms,
   a. Justification for biologics or drug development,
   b. Planning marketing strategies.
4. Livestock producers,
   a. Planning management strategies, and
   b. Planning vaccination or treatment strategies.

One area requiring this type of information is for control or eradication programs in order to (1) justify or reject programs including cost-benefit analysis, (2) plan new programs, and (3) to evaluate and manage existing programs. The lack of valid information has often hampered efforts for these purposes. The handling of data from control or eradication programs for purposes of evaluating trends or progress will be discussed later.

A second area requiring statistically based information is in research for justification or rejection and planning of research projects. Valid information will help in the setting of priorities.

A third area requiring statistically based information is for biologics or drug firms in the justification for biologics or drug development and in the planning of marketing strategies.

A fourth area requiring statistically based information is in livestock
production for planning management strategies and vaccination or treat-
ment strategies. In this area, it is necessary to be able to relate differences
in management practices to differences in the effect of disease. This may
involve the livestock manager directly or may involve a herd health plan
veterinary practice.

**Non-Statistically Based Requirements:** Non-statistically based re-
quirements refer to those needs for which information does not need to be
and generally is not obtained from probability sample surveys or from a
complete census of the population. This does not mean that statistically
based inferences can never be obtained from such information. Figure 2
illustrates the various areas of non-statistically based need.

![Figure 2. Non-Statistically Based Uses for Animal Disease Information.](image)

1. Foreign Disease Detection.
2. Certification for Interstate and Export Shipment.
   a. Certification of States, Counties, or Local Areas.
   b. Certification of Herds.
3. Emerging Disease Alert or Rare Disease Information.
4. Cyclical Disease Alert for Vaccination Planning, etc.
5. Laboratories.
   a. Laboratory Management;
      (1) For financial budgeting,
      (2) For testing for new or additional diseases, and
      (3) For diagnostic methods development.
   b. Diagnostic Support;
      (1) For research,
      (2) For field surveys or field investigations, and
      (3) For control or eradication programs.
6. Detection of Foci of Infection for Control or Eradication Programs.

One area of non-statistically based need is that of foreign disease
detection. A second need that is similar in difficulty is that of detecting the
occurrence of emerging or rare diseases. One difference is that it may be
more crucial to acquire information on foreign diseases.

A third area of non-statistically based need is that of certification for
interstate and export shipment. This may be thought of as involving two
categories. They are the certification of states, counties, or local areas and
the certification of herds.

A fourth area of non-statistically based need is that of being alerted to
the upsurge of diseases of a cyclical nature. This can be important for
purposes of being alert for changes in vaccine policy. It can also be
important with regards to such diseases as vesicular stomatitis as it
pertains to foreign animal disease monitoring.

A fifth area of non-statistically based need is that of laboratories. They
require information for financial budgeting purposes. Information may be
required on testing for unusual diseases. Diagnostic methods development
may need to be done in new areas. They also need to plan for diagnostic support for research, for field surveys or field investigations, or for control or eradication programs.

A sixth area of non-statistically based need is that of detection of foci of infection for control or eradication programs. This need requires differing systems depending upon the nature of the disease and the goal of the program. It may be desirable to subject systems of detection dealing with this need to statistical evaluation.

**SOURCES OF ANIMAL DISEASE INFORMATION**

Once the various needs for animal disease surveillance information have been identified, it is then necessary to identify the various possible sources of such information. One thing that has contributed to the lack of progress in developing systems for statistically based animal disease information needs has been the tendency to think that one animal disease information system could meet all needs.

There have been three general sources of animal disease information. These sources are the records of on-going control or eradication programs, special surveys, and traditional animal disease reporting sources. Traditional animal disease sources include data from practicing veterinarians, diagnostic laboratories, and data that do not pertain directly to funded animal disease control programs but is collected ancillary to these programs.

The various sources of information can be regarded as involving two types of populations. They are specifiable populations of animal disease information and unspecifiable populations of animal disease information. In general, special surveys fall into the specifiable population group while the records of on-going control or eradication programs and traditional animal disease reporting sources fall into the unspecifiable population group. Figures 3 and 4 illustrate these two types of source populations.

**Difference Between Specifiable and Unspecifiable Population Sources**

Specifiable population sources refer to those populations, whether specialized or generalized, to which extrapolations can be made from the collection of data to the wider population. A known population at risk or denominator is required in order to accomplish this extrapolation.

Unspecifiable population sources refer to those populations where extrapolations cannot be made from the collection of data to a population of interest. This may be due to the lack of a known population at risk or denominator.

**Specifiable Population Sources of Animal Disease Information**

Specifiable population sources can be thought of as involving (1) on-farm random sampling of the complete population, (2) a random sample of some special farm population, either on the farm or off the farm, and (3) the
slaughter inspection population. Figure 3 illustrates the various specifiable population sources of information. As stated above, specifiable populations are those populations where extrapolations can be made from the collection of data to the wider population.

However, these extrapolations can be made only from a probability sample survey of the entire population or if a complete or near complete census of the entire population has been conducted as is the case with visual slaughter inspection. Statistical or probability based random sampling requires that every herd and/or animal in the population have a known probability different from zero of being selected for the sample.

Figure 3. Sources of Animal Disease Information - Specifiable Populations.

A. On-Farm Random Sample, i.e., Probability Sample Surveys.
   1. Ongoing General Disease Condition Surveys.
      a. Little or No Diagnostic Support - Doane System.
      b. Diagnostic Confirmation - Modified Minnesota System.
   2. Mixed Ongoing General Condition and Specific Disease Surveys.
      a. Modified Minnesota System.
      b. Proposed APHIS System.
   3. Special Surveys, i.e., trichina survey in garbage fed swine.

B. Random Sample of Special Populations, i.e.,
   1. DHIA Program or Quality Milk Program herds,
   2. Poultry Organizations, and
   3. Brucellosis MCI Samples for Specific Diseases.

C. Slaughter Inspection.
   2. Laboratory Confirmation with a Probability Sample Survey.
   3. Specific Disease Serum Survey With Residue Random Sampling System.

On-farm random sampling: On-farm random sampling of the entire population can be regarded as falling into three general groups. One group deals with ongoing general animal disease condition surveys. The second group deals with mixed ongoing specific animal disease and general animal disease condition surveys. The third group consists of specific one-time surveys.

The category of ongoing general animal disease condition surveys is subdivided into those with little or no veterinary diagnostic support and those with veterinary diagnostic confirmation. The first subgroup involves interview surveys by non-veterinarians or mail surveys involving the keeping of a diary by the farm operator with little or no veterinary participation while the second subgroup has a veterinarian as a direct participant in providing some veterinary confirmation.

The category of mixed ongoing specific disease and general disease conditions surveys involves more veterinary diagnostic support with some laboratory confirmation. The category of special one-time surveys includes
a trichina survey in garbage fed swine which was completed by VS in 1966 (Jefferies, 1966).

**Special Population Sources:** There can also be random sampling of special populations. Examples include Dairy Herd Improvement Association (DHIA) program or quality milk program herds, poultry organizations, and brucellosis Market Cattle Identification (MCI) samples. The brucellosis MCI samples would be used for specific diseases such as anaplasmosis.

There is a vast amount of data on herd health recorded in DHIA herd books which is not retrieved. It might be possible to do a random sampling of DHIA herds for purposes of retrieving this information. However, recording might not be uniform. This would bias the data. Also, only about thirty percent of the milk cow population is on DHIA and there might be a considerable difference between DHIA herds and other dairy herds in health characteristics. Consequently, results would apply only to the DHIA population.

With regard to the quality milk program, many, if not most herds, are subjected to quality milk testing. It might be feasible to survey a random sample of herds having different levels of cell counts for information on mastitis. However, the policy on antibiotic residues with the concomitant withholding of milk from treated cows might render this a poor population to sample.

There may be other problems with this type of survey. However, cell counts may be a good criteria for purposes of subsampling an on-farm sample of herds such as that proposed for the NADS system for purposes of estimating losses due to mastitis.

Since samples are collected on most slaughter cows for purposes of the brucellosis MCI program, this population can be validly sub-sampled as a definable or specifiable population. As pointed out above, this was done for anaplasmosis. The integrated poultry industry could be sampled for purposes of getting composite information on losses in poultry.

**Slaughter population:** The third general type of specifiable population that can provide information is the slaughter inspection population. This information falls into three general groups. They are a visual inspection census, a definitive laboratory confirmation of the visual inspection results by means of a probability sample survey, and a serum survey for specific diseases with the use of the residue random sampling system.

However, this information is useful only for those diseases that are manifested at slaughter. Even with these diseases, the degree of usefulness varies with the relative degree that losses due to a particular disease are evident at slaughter as compared to being evident on the farm.

**Importance of Stratification by Herd Size:** In selecting probability based random samples of the farm population, it is important to stratify by herd size. This is due to the fact that there can be basic disease differences by herd size in percentage of herds infected and infection rate within the
herd. Differences in percentage of herds infected for pseudorabies have been shown (McCallon and Beal, 1982b).

Unspecifiable Population Sources of Animal Disease Information

Unspecifiable population sources can be thought of as involving (1) the practicing veterinarians as a group, (2) the diagnostic laboratory, (3) local veterinarian knowledge, and (4) specific disease control or eradication activities. Each of these categories have further categorization and are illustrated in Figure 4.

Figure 4. Sources of Animal Disease Information - Unspecifiable Populations.

A. Practicing Veterinarian.
   2. Traditional Postcard or Letter Questionnaire.
   3. Herd Health Plan System.

B. Diagnostic Laboratories.
   1. Local Reports.
   2. Central Reports.

C. Local Veterinarian Knowledge.
   1. Word of Mouth plus Extension VMO or State VMO Newsletters.
   2. Word of Mouth plus Field VMO plus Hotline Report - Foreign Disease.
   3. Local Practitioner plus Field VMO Knowledge - Certification.

D. Specific Disease Control or Eradication Operations.
   2. Concentrated Area Testing or Inspection.
   3. Reporting of Sick Animals.

Formal Reports of Practicing Veterinarian: Practicing veterinarians as a group can supply information. This information can be regarded as falling into three categories. These are (1) the traditional postcard or letter questionnaire, (2) individual herd health plans or a herd health plan system, and (3) a special probability panel of practicing veterinarians and their clients such as the Minnesota system (Diesch, et al, 1974, 1979, 1981; Martin and Diesch, 1980). All three of these categories can be thought of as falling into the unspecifiable population source of information class.

It is obvious why the traditional postcard or letter questionnaire as represented by the defunct NRAD is so classified. It is less obvious why the herd health plan and the special panel of practitioners and their clients fall into this class. The reason rests with the fact that some farmers do not use veterinarians at all while those using veterinarians do so with a varying and unknown degree of regularity.

Consequently, it is not known what the relationship of the population observed by the practicing veterinarian is to the entire population. It is not
known what proportion of the animals are under surveillance by him all of the time and what proportion are under varying degrees of surveillance.

This problem affects the selection of a random group of clients in the case of the special probability panel of practicing veterinarians and their clients. The problem was brought out by a special validation study of the Minnesota system (Diesch, et al, 1981). It was shown in this validation study that results could not be extrapolated from the sample of clients to the entire population.

A similar problem exists in the case of herd health plans. It is not known what the relationship of herds under these types of plans is to the general population of herds. Due to the fact that these herds are in herd health plans, there will be unknown amounts of difference between them and the rest of the population. Consequently, unless there is a population of herd health plan herds that is similar in size to the DHIA population in terms of percentage of national beef, dairy, or hog inventory, this population cannot be considered to be a special population warranting random sampling.

In addition, a computer list comprised of the herd size and herd owner's name and address for all herd health plan herds would have to be constructed so that probability based random sampling could be conducted. There would also have to be stratification by herd size due to the above mentioned existence of herd size differences.

Information From Diagnostic Laboratories: Diagnostic laboratories can also supply information. This consists of local reports of individual laboratories and composite reports of a collection of laboratories. As mentioned above, diagnostic laboratories also fall into the unspecifiable population source of information class.

The reason for this classification of laboratory information, as discussed earlier, is that laboratory data will not provide information about disease prevalence or incidence and economic loss. In addition, there have been reports of a relationship between distance from a laboratory and frequency of submission. Also, once a practitioner has become familiar with a particular disease entity, he will submit fewer specimens to a laboratory. However, as shown in Figure 2 and Table 2, there are important uses for laboratory information.

Local Veterinarian Knowledge: A third category of information in this general class is local veterinarian knowledge. There are three subgroups in this category. They are (1) word of mouth with a State VMO or Extension VMO newsletter, (2) word of mouth with the regulatory field VMO and a hotline report for foreign animal diseases, and (3) local practitioner knowledge and the regulatory field VMO knowledge for certification for interstate or international shipment of livestock. While this category of surveillance information falls into the unspecifiable population source of information class, local veterinarian knowledge is very important.

Word of mouth with State VMO or Extension VMO newsletters will provide important information about sudden upswings of various diseases.
Word of mouth with the regulatory field VMO and a hotline report for foreign animal diseases is one of the major ways, if not the major way, of detecting foreign animal disease outbreaks. While other methods of gaining information for purposes of export and interstate certification have been proposed, local practitioner knowledge plus the regulatory field VMO knowledge will remain important in this case.

**Disease Control or Eradication Operations:** It has been an article of faith among many people that data from animal disease control or eradication programs represent a reliable set of data for purposes of estimation of trends or program progress and for purposes of program evaluation even if data from the now defunct NRAD were unreliable for the purpose of estimating trends. However, experience has shown that this is often not the case and there are many problems with interpretation of such data.

Disease control or eradication operations dealing with specific diseases fall into the class of unspecifiable population information sources. This category is further subdivided into three sub-groups. They are (1) concentrated MCI surveillance, (2) concentrated area testing or inspection, and (3) reporting of sick animals.

The reason that this category falls into the unspecifiable population source of information class is the undefinable nature of the information for purposes of making estimates of trend, prevalence, or incidence. However, if the MCI population is sufficiently comprehensive, it can provide estimates of trend. This also applies to the brucellosis milk ring test (BRT) in terms of estimating trend. Problems associated with evaluating data concerning bovine tuberculosis (TB), bovine brucellosis, and hog cholera will be discussed later. The evaluation of the effectiveness of surveillance systems for these purposes will also be discussed later.

**Active versus Passive Surveillance as Sources of Information**

Active and passive surveillance have been discussed by Anderson (1982). He has described various aspects of active surveillance. Some aspects apply to specifiable populations and others apply to unspecifiable populations. Differences between Arkansas and the rest of the United States have been discussed above with respect to the defunct NRAD. These differences would indicate that most of the country was practicing passive surveillance and that Arkansas was practicing a considerable degree of active surveillance with regard to the diseases reported in the NRAD. However, even in Arkansas, the NRAD dealt with a unspecifiable population.

Organized and intensive disease control or eradication efforts can be likened to constituting active surveillance. The hog cholera eradication program is an example where each of the states progressed from phases of preparation to the final phase of eradication. The first phase was a period of passive surveillance while the final phases were periods of active surveillance. Organized and intensive disease control efforts represent examples of active surveillance that deal with unspecifiable populations.
while the survey for trichina in garbage fed swine represents an example of active surveillance that dealt with a specifiable population.

**CORRELATION OF ANIMAL DISEASE INFORMATION USES AND SOURCES**

Once the possible uses for animal disease information and the various sources of animal disease information have been identified, it is desirable to see how uses and sources correlate together. Table 2 shows a correlation of animal disease information and sources. An earlier version of this table was prepared by the author as a working paper for the 1974 NAS study.

**Table 2. Correlation of Animal Disease Information Uses and Sources.**

<table>
<thead>
<tr>
<th>Required Uses for Animal Disease Information</th>
<th>Usefulness for General Disease Conditions</th>
<th>Usefulness for Specific Animal Diseases</th>
<th>Usefulness for Diseases Manifested At Slaughter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sources of Information</td>
<td>Statistically Based Uses</td>
<td>Non-Statistically Based Uses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Incidence &amp; Prevalence Rates</td>
<td>Detect Foreign Disease</td>
<td>Detect Emer. Disease</td>
</tr>
<tr>
<td></td>
<td>Detect</td>
<td>Certify Moving Disease</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trend</td>
<td>Detect</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Losses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Random Sample</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doane type</td>
<td>Some</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Modified Minn.</td>
<td>Some</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Proposed APHIS</td>
<td>Most</td>
<td>No</td>
<td>Some</td>
</tr>
<tr>
<td>Practicing DVM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minnesota system</td>
<td>Some</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Post card</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Herd Health Plan</td>
<td>Some</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Special Population</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DHIA type</td>
<td>Few</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Diagnostic Lab</td>
<td>Hints</td>
<td>No</td>
<td>Some</td>
</tr>
<tr>
<td>Local Knowledge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local DVM</td>
<td>Hints</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Local farmer</td>
<td>No</td>
<td>Yes</td>
<td>Hints</td>
</tr>
<tr>
<td>Random Sample</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doane type</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Modified Minn.</td>
<td>Some</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Proposed APHIS</td>
<td>Most</td>
<td>No</td>
<td>Some</td>
</tr>
<tr>
<td>Practicing DVM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minnesota system</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Post card</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Herd Health Plan</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Special Population</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DHIA type</td>
<td>Few</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>MCI serum survey</td>
<td>Few</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Diagnostic Lab</td>
<td>Hints</td>
<td>No</td>
<td>Some</td>
</tr>
<tr>
<td>Local Knowledge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local DVM</td>
<td>Hints</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Local farmer</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Sltr. Inspection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual census</td>
<td>Few</td>
<td>Few</td>
<td>Some</td>
</tr>
<tr>
<td>Random sample confirmation</td>
<td>Some</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Serum survey</td>
<td>Some</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

---
The earlier version was subsequently included in the 1977 VS study (Harper, et al, 1977). This table was constructed and revised after consultation with a number of VS staff personnel. Some of the aspects between uses for information and sources of information have been discussed both in the 1977 VS study and by Beal (1975).

Table 2 lists statistically based and non-statistically based uses for information which have been discussed above. The statistically based use category is subdivided into (1) incidence and prevalence rates, (2) trend, and (3) losses. The non-statistically based use category is subdivided into (1) detection of foreign diseases, (2) certify for movement, (3) detection of emerging diseases, (4) alerting to the occurrence of a disease cycle, and (5) laboratory management.

Table 2 also lists sources of information which have been discussed above. They are (1) random samples, (2) the practicing veterinarian, (3) special populations, (4) the diagnostic laboratory, (5) local knowledge, and (6) slaughter inspection. These general categories are further subdivided. The first five categories are listed twice. This is in order to evaluate their usefulness for general disease conditions and for specific animal diseases. Slaughter inspection is evaluated for its usefulness for diseases with major manifestations at slaughter.

Table 2 then shows the usefulness of the sources for the various uses. Six categories of usefulness are given. They are (1) yes, (2) most, (3) some, (4) few, (5) hints, and (6) no. “Yes” means that the source is useful for that purpose. “Most” means that the source is usually useful for that purpose. “Some” means that the source is useful for that purpose some of the time. “Few” means that the source is not useful for that purpose in most cases. “Hints” means that the source will provide hints of such things as trend and will provide hints of the occurrence of an emerging disease. “No” means that the source has no usefulness for that purpose.

RESEARCH IN STATISTICALLY VALID METHODS OF OBTAINING INFORMATION

Over the years, there has been research by various groups into methods of obtaining valid information. These studies consisted of probability sample surveys of one kind or another. These activities which extend back for about 35 years appear to be limited in number in the United States but are more numerous in Great Britain.

Iowa Study: The earliest known study was in the State of Iowa in 1946-1947 (Anon, 1947; Snedecor, 1947; Newton 1947). A description of the problems encountered in the study were given in an anonymous typed report. It was the conclusion of the anonymous report that veterinary interviewers could collect more diagnostically accurate data than non-veterinary interviewers. As far as is known, no numerical results were published. There may have been additional work during this period of time as Schroeder (1946) makes mention of surveys being conducted under the auspices of the NRC.
British Studies: Research then took place in Great Britain in the late 1950's and early 1960's (Leech, et al, 1960, 1964a, 1964b, 1968; Leech, 1971a, 1971b; and Leech and Sellers, 1979). These studies covered disease, wastage, and husbandry in the British dairy herd (Leech, et al, 1960 and 1964a), calf wastage and husbandry in Britain (Leech, et al, 1968), and losses in breeding ewes (Leech, et al, 1964b). These activities were directed towards a random sample of herds and flocks. The experiences involved in these surveys were reviewed by Leech (1971a and 1971b) and Leech and Sellers (1979).

Minnesota Study: Work then began in Minnesota in 1970 on a reporting and surveillance system for the State of Minnesota (Diesch, et al, 1974: Diesch and Martin, 1979; Martin and Diesch, 1980; and Diesch et al., 1981). The goal was to develop a system which would be better than the previous post-card system. In this new system, a statistically determined number of herds from various areas of the State were randomly selected and surveyed by private veterinarians on a regular basis so that for the first time in the United States, one could draw inferences concerning disease prevalence and trends over a period of years.

While this system was based upon a random drawing of herds, these herds were clients of private practitioners. This was in contrast to the earlier surveys in Iowa and Great Britain. It was not known as to what the relationship of disease prevalence between this sample and the population at large would be.

A subsequent validation study showed that there were some differences between this type of sample and one drawn from the entire population of herds (Diesch, et al, 1981). This is explained in part in that the practicing veterinarian did not always draw a random selection of his clients. Instead, he might draw the first client that he visited during the month. There were other problems. This system provided little information concerning economic losses.

Development of a National Animal Disease Surveillance (NADS) System: As a result of the validation study in Minnesota, recommendations were made that an on-farm random sampling system should be conducted using regulatory VMO's rather than practicing veterinarians as data collectors. At about the same time, McCallon independently made a similar recommendation (Sharman, 1980; McCallon, 1981a). As a result, APHIS formulated a five phase plan and an APHIS position (Poppensiek, et al 1981) with the goal of developing the NADS system. Leadership was taken by USAHA due to the revival of the Morbidity and Mortality committee in 1979 (Goldstein, 1979).

EVALUATION OF ANIMAL DISEASE INFORMATION FROM CONTROL PROGRAMS

It was pointed out above that it has been an article of faith among many people that animal disease control or eradication program data represents a reliable set of data for purposes of estimation of trends or program progress and for purposes of program evaluation. It was also pointed out
that experience has shown that this is often not the case and there are many problems with the interpretation of such data.

Due to a continuing necessity to evaluate progress which is being obtained with control or eradication programs, it is desirable to discuss this problem. This problem has been examined for bovine TB and brucellosis by Ray (1980 and 1983) and Beal (1980a). It has also been examined for hog cholera by Beal (1980a).

Examples have been observed of program data being erroneously interpreted because of a failure to understand the biases in the data. This has resulted in a failure to understand trends with regard to brucellosis or TB (Hubbert and Hagstad, 1979). It has resulted in a belief that there was a significant rise in hog cholera in the late 1960's (Reimann and Bankowski, 1973; Schwabe, et al, 1977).

Interpretation of Brucellosis and Tuberculosis Program Data:

Ray (1980 and 1983) has discussed the biased nature of brucellosis program data for purposes of program evaluation. This includes problems with infected herd data. It has been found that the results of program testing provides biased and inconsistent estimates of infection rate with the use of on-farm reactor rates for bovine TB and bovine brucellosis.

This was found to be especially critical since without consistent estimates of infection, even if biased, estimates of trend and of progress were erroneous. This was even the case with area testing for the two diseases. This results from testing not being random with the area testing occurring in areas thought to have a higher level of infection and from the retesting of quarantined herds. This resulted in biased on-farm reactor rates for both diseases. The problem became even greater with the advent of MCI as the major case finding tool for TB and brucellosis.

With respect to bovine TB (USDA, 1966; Beal, 1980a), it was found that results from slaughter inspection provided more reliable estimates of trend than did on-farm reactor rates. This was due to a coverage of a high proportion of slaughter cattle under federal inspection. Results of animals condemned or passed for cooking at slaughter, retained at slaughter, on-farm reactor rates, and lesion reactor rates were compared.

This type of information can be plotted on probability or semi-log graph paper. A graph of results for TB was presented. Slaughter results gave a more consistent line than did on-farm reactor results with an almost straight line between 1925 and 1965. Table 3 presents data for 1917 and for every fifth year from 1920 through 1965 in rates per 10 million slaughtered and tested. It can be seen that slaughter inspection rates indicate a greater amount of progress than do on-farm reactor rates.

Information for the brucellosis ring test (BRT) and from MCI testing gave results that were similar. With brucellosis milk ring test results for 1955 to 1964, and market cattle brucellosis testing results for 1967 to 1971, one obtained plots which were rather straight. This was an indication that in terms of year-to-year trends, these were better measures of incidence than were area testing results. If results are consistent, they will follow
Table 3. Results of Program Testing and Slaughter Inspection for Bovine Tuberculosis for Selected Years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Condemned &amp; PFC*</th>
<th>Retained</th>
<th>Lesion Reactors</th>
<th>All Reactors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1917</td>
<td>53,100</td>
<td>210,700</td>
<td>320,800</td>
<td></td>
</tr>
<tr>
<td>1920</td>
<td>40,700</td>
<td>162,400</td>
<td>409,700</td>
<td></td>
</tr>
<tr>
<td>1925</td>
<td>42,100</td>
<td>151,100</td>
<td>306,400</td>
<td></td>
</tr>
<tr>
<td>1930</td>
<td>19,070</td>
<td>75,360</td>
<td>168,800</td>
<td></td>
</tr>
<tr>
<td>1935</td>
<td>6,585</td>
<td>24,330</td>
<td>149,200</td>
<td></td>
</tr>
<tr>
<td>1940</td>
<td>2,096</td>
<td>8,797</td>
<td>46,100</td>
<td></td>
</tr>
<tr>
<td>1945</td>
<td>1,061</td>
<td>4,019</td>
<td>24,100</td>
<td></td>
</tr>
<tr>
<td>1950</td>
<td>608</td>
<td>3,149</td>
<td>18,790</td>
<td></td>
</tr>
<tr>
<td>1955</td>
<td>156</td>
<td>503</td>
<td>12,090</td>
<td></td>
</tr>
<tr>
<td>1960</td>
<td>48</td>
<td>230</td>
<td>14,990</td>
<td></td>
</tr>
<tr>
<td>1965</td>
<td>28.3</td>
<td>190</td>
<td>7,855</td>
<td></td>
</tr>
</tbody>
</table>

* PFC stands for Passed for Cooking.

The reason that results from slaughter inspection for bovine TB and from BRT or MCI for brucellosis bovine provide better estimates of trend than do results from area testing and other on-farm testing resides in the type of population involved. There is a specifiable population source of information in the case of slaughter inspection, BRT testing, and MCI testing in that practically the entire population of slaughter or cull animals are subject to inspection or testing in the one case and the entire population of herds selling milk or cream is subject to BRT testing in the other case. This is not the case with on-farm testing in that the population is not specifiable in terms of trend evaluation.

Interpretation of Hog Cholera Program Data: Problems of measuring progress have also been observed for hog cholera. It was found that the number of reported hog cholera cases that were confirmed to be hog cholera was a poor measure of progress. This was due to the fact that there was an ever increasing emphasis on getting suspicious animals and herds reported. This means that the number of confirmed cases was more a measure of program activity than of the level of infection.

This relates to there being varying degrees of passive and active surveillance as the program progressed through the various phases in the various states. The result was a source of information with an unspecifiable population. This resulted in a requirement for another source of information in order to evaluate trend or progress.

In doing this, it was found that two types of data correlated quite closely from 1964 to 1973. One of these was the ratio of confirmed cases to those cases that proved to be negative to hog cholera while the other was the results of slaughter inspection for hog cholera. The fact that these two rates are closely correlated is significant since the two rates are based upon two completely different sets of data. This meant that the ratio of con-
confirmed cases to those that proved to be negative to hog cholera was a better measure of progress than was the number of confirmed cases.

Table 4. Rate of Confirmed Cases per 1,000 Negative Investigations for Hog Cholera.

<table>
<thead>
<tr>
<th>Year</th>
<th>Confirmed Cases</th>
<th>Negative Cases</th>
<th>Ratio of Confirmed to 1,000 Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY Totals</td>
<td>CY Totals</td>
<td>FY Totals</td>
<td>CY Totals</td>
</tr>
<tr>
<td>1964</td>
<td>1,117</td>
<td>545</td>
<td>2,050</td>
</tr>
<tr>
<td>1965</td>
<td>1,110</td>
<td>617</td>
<td>1,799</td>
</tr>
<tr>
<td>1966</td>
<td>583</td>
<td>849</td>
<td>687</td>
</tr>
<tr>
<td>1967</td>
<td>689</td>
<td>1,541</td>
<td>447</td>
</tr>
<tr>
<td>1968</td>
<td>849</td>
<td>3,185</td>
<td>267</td>
</tr>
<tr>
<td>1969</td>
<td>1,055</td>
<td>4,342</td>
<td>243</td>
</tr>
<tr>
<td>1970</td>
<td>1,231</td>
<td>4,626</td>
<td>266</td>
</tr>
<tr>
<td>1971</td>
<td>418</td>
<td>5,597</td>
<td>74.7</td>
</tr>
<tr>
<td>1972</td>
<td>76</td>
<td>3,372</td>
<td>22.5</td>
</tr>
<tr>
<td>1973</td>
<td>163</td>
<td>4,020</td>
<td>40.5</td>
</tr>
<tr>
<td>1974</td>
<td>2</td>
<td>1,504</td>
<td>1.33</td>
</tr>
</tbody>
</table>

* FY = Fiscal Year and CY = Calendar Year.

It was found that this ratio had a plot similar to the results of slaughter inspection for hog cholera when plotted on semi-log graph paper. The ratio of confirmed cases to negative cases is based upon the same set of data as is the confirmation rate, which is the ratio of confirmed cases to total suspicious cases before negative cases are subtracted. Graphs of the confirmation rate and slaughter rate are shown elsewhere (Beal, 1980a).

Some of the data is shown in Table 4 for results of field investigations and in Table 5 for results of slaughter inspection. Table 4 shows the number of confirmed cases and number of negative cases by fiscal year and calendar year. It also shows the ratio of confirmed cases per 1,000 negative cases. Table 5 shows the condemnation rate per 100 million animals inspected at slaughter.

It can be seen from these two tables that while the number of confirmed cases increased from 1966 to 1969 the ratio of confirmed to negative declined from 1964 to 1972 except for a slight pause in 1969 and 1970. It can be seen that there was also an increase in 1972 and 1973 when an epidemic occurred.
There are two reasons for the close relationship between the ratio of confirmed cases to negative cases and condemnation rate at slaughter. One reason is that the level of diseases responsible for the negative cases was not affected by the hog cholera program. The second reason is that slaughter inspection represents a specifiable population as an information source. This is true despite the diagnostic error which results at inspection.

These two sets of data on bovine TB and hog cholera are examples of the undefinable nature of disease control program data in terms of a source of animal disease information for purposes of estimating trends. However, they also point out sound inferences can be obtained from such data if care is taken. As pointed out above, the same problem applies to brucellosis. The same problem also applied to sheep and cattle scabies.

<table>
<thead>
<tr>
<th>Year</th>
<th>Condemnation Rate Per 100 Million</th>
</tr>
</thead>
<tbody>
<tr>
<td>1948</td>
<td>13,017</td>
</tr>
<tr>
<td>1949</td>
<td>11,120</td>
</tr>
<tr>
<td>1950</td>
<td>13,483</td>
</tr>
<tr>
<td>1951</td>
<td>14,252</td>
</tr>
<tr>
<td>1952</td>
<td>11,612</td>
</tr>
<tr>
<td>1953</td>
<td>7,732</td>
</tr>
<tr>
<td>1954</td>
<td>5,008</td>
</tr>
<tr>
<td>1955</td>
<td>3,216</td>
</tr>
<tr>
<td>1956</td>
<td>3,507</td>
</tr>
<tr>
<td>1957</td>
<td>3,797</td>
</tr>
<tr>
<td>1958</td>
<td>3,984</td>
</tr>
<tr>
<td>1959</td>
<td>2,796</td>
</tr>
<tr>
<td>1960</td>
<td>3,495</td>
</tr>
<tr>
<td>1961</td>
<td>3,731</td>
</tr>
<tr>
<td>1962</td>
<td>2,302</td>
</tr>
<tr>
<td>1963</td>
<td>1,356</td>
</tr>
<tr>
<td>1964</td>
<td>970</td>
</tr>
<tr>
<td>1965</td>
<td>460</td>
</tr>
<tr>
<td>1966</td>
<td>186</td>
</tr>
<tr>
<td>1967</td>
<td>146</td>
</tr>
<tr>
<td>1968</td>
<td>218</td>
</tr>
<tr>
<td>1969</td>
<td>220</td>
</tr>
<tr>
<td>1970</td>
<td>71.9</td>
</tr>
<tr>
<td>1971</td>
<td>9.33</td>
</tr>
<tr>
<td>1972</td>
<td>3.61</td>
</tr>
<tr>
<td>1973</td>
<td>2.64</td>
</tr>
</tbody>
</table>

STATISTICAL EVALUATION OF ANIMAL DISEASE DETECTION METHODS

The undefinable nature of animal disease control or eradication populations as sources of information has proven to be an important factor in the evaluation of animal disease surveillance systems which are used for the detection of infected herds or flocks. This evaluation has included the establishment of necessary sample sizes for detecting infected herds under specified conditions and the evaluation of the effectiveness of surveillance systems. It has been found necessary to attempt statistical evaluations of the various surveillance programs used in doing this.

The hypergeometric probability function has proven to be useful for this purpose. This probability function was first used in the U.S. Department of Agriculture (USDA) by Harvey in 1959 for purposes of estimating required sample sizes under different conditions for detecting infection within herds for brucellosis (Harvey, 1959; USDA, 1960; and Beal, 1983). In doing these evaluations, it has been necessary to assume randomness of the population structure. This often is not a valid assumption. However, probability functions depend upon this basic assumption.
This work resulted in a change in how range beef herds were handled in area testing for purposes of detecting brucellosis in cattle. This change consisted of doing partial testing of these herds which reduced the number of animals that were tested. There were problems in the application of this procedure. A major one consisted of the assumption of what was a herd. The assumption of randomness required random mixing of all of the animals in the herd. However, many herds consisted of several separate units which were considered to be one single unit for purposes of sampling.

There was another major problem in this procedure. This was the difficulty with which sample sizes were estimated. In investigating this problem, the author developed an approximation to the hypergeometric in 1963 which facilitated the computation of required sample sizes (Beal, 1983). This approximation was subsequently used in investigating the efficiency of traceback of infected animals from slaughter for bovine TB control.

Where MCI was intended from the first to replace area testing for brucellosis, it was an adjunct at first to area testing for bovine TB eradication. Required coverage at first for brucellosis was 5 percent of the adult cow population (USDA, 1963). This was equal to about one-third of the cull beef cows and one-sixth of the cull dairy cows.

The author first investigated the efficiency of the MCI system for brucellosis as applied to the TB program in 1965 (Flint, 1965; USDA, 1966; Ranney, 1969; and Beal, 1983). This was due to concerns by State-Federal TB program officials about the adequacy of the level of coverage required for the brucellosis MCI program as applied to the bovine TB program.

In this investigation, the affect of differing herd sizes, cull rates, infection rates, and traceback rates upon the detection of TB in individual herds was examined. The results of this investigation were also applicable to brucellosis. The author later (Beal, 1977) investigated the efficiency of the MCI system in the simulation of the eradication of brucellosis for the entire population of herds rather than for the detection of individual herds. In this investigation, the affect of two cull rates and two traceback efficiency rates were examined.

Implicit in these various evaluations of animal disease surveillance was the assumption of randomness, whether it was randomness of culling, randomness of marketing, randomness of infection within the herd, or randomness of other factors. It was due partially to the undefinable populations involved that these evaluations had some drawbacks, whether it was with estimating sample size or with evaluating effectiveness of the surveillance system. However, important inferences were obtained.

**SUMMARY**

Various perspectives of animal disease surveillance have been examined. These have included (1) a review of efforts to develop a surveillance system for diseases other than organized control or eradication program diseases, (2) the reasons for having animal disease surveillance, (3) the
sources of animal disease surveillance information, (4) the relationship between uses for information and sources of information, and (5) various statistical aspects of animal disease surveillance information.

REFERENCES


34. Leech, F. B., M. P. Vessey, and W. D. Macrae. 1964a. Disease, wastage, and


THE USE OF MATHEMATICAL MODELS IN ANIMAL DISEASE PROGRAM EVALUATION

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In animal disease eradication and control programs in the United States, the term Animal Health Economics implies the procedure of cost-benefit analysis (CBA). CBA will be discussed briefly but the discussion will concentrate upon the need for sound animal disease loss information and the sound mathematical modeling of alternative animal disease eradication and control programs since the procedures of CBA have been covered in detail elsewhere.

Cost-benefit analysis has been used in one form or another for many years. It asks and answers the question of whether the cost of a particular activity is justified by the benefit to be obtained from that activity. Cost-benefit analysis has been used in its present sophisticated form for the evaluation of the United States (U.S.) animal disease eradication and control programs by Veterinary Services (VS), Animal and Plant Health Inspection Service (APHIS), since about October 1966.

The idea behind the presently used form of CBA is the concept that one can invest the money at some rate of interest. The benefits which one might expect to obtain from the program and the costs of the program are both estimated in physical form and then converted to monetary form. These costs must include all costs of the program including all government, industry, producer, and marketing costs. One then converts these year-to-year costs and benefits back to the value of money today. This procedure is called discounting and has been discussed by various authors. This procedure has been outlined briefly by Kryder (1980) for animal disease program evaluation. The methodology is also described by Mishan (1976).

BASIC COMPONENTS OF COST-BENEFIT ANALYSIS

There are several components in a cost-benefit analysis of an animal disease control or eradication program. Some of these are the estimation of losses per animal from a disease, the estimation of the current incidence of the disease, the combining of the losses per animal and the incidence of the disease to obtain the total losses from the disease, and the projection of year-to-year incidence and hence losses for the various alternative programs and for no program. These factors are discussed briefly here and in greater detail elsewhere by the author (Beal, 1980a).

A fifth component is the estimation of the cost of the various alternative programs. This component is very important and has been discussed by Beal (1980a) and McCallon (1973). The remaining components are measures of magnitude of the results of CBA and the effect on consumer prices. These various factors are discussed briefly elsewhere by the author (Beal,
1980a) and in greater detail by Mishan (1976) and various other authors.

Estimation Of Losses Per Animal

The estimation of physical loss from disease for individual animals is always a problem. In the case of proposed new program diseases or non-program diseases, such as pseudorabies, bluetongue, or bovine leukemia, the problem is usually greater than it is for ongoing programs such as brucellosis and tuberculosis (TB) in cattle, however, even with these latter diseases, there has been difficulty in obtaining adequate information. It is important to have pilot studies in which such information is obtained. It has been found that changed husbandry conditions may affect losses per animal.

Estimation of Current Incidence Or Prevalence Of Disease

The estimation of the current incidence or prevalence of a disease is frequently a problem, even when the disease is one with an ongoing program such as brucellosis or TB. Program records often give a biased picture of the incidence or prevalence of a disease. This was the case with bovine TB and bovine brucellosis, even when there was testing of most of the herds in complete areas, as opposed to the current testing of herds identified by tracing infected animals found at market or slaughter. This bias in complete area testing is discussed by Beal, (1980a) and (1980b), and Ray (1980).

When one deals with non-program or proposed program diseases, such as equine infectious anemia (EIA), anaplasmosis, and bluetongue, where one does not have program data available, the problem of estimating the current incidence or prevalence can be even greater. Serological probability sample surveys have been conducted for anaplasmosis and bluetongue, while the results of testing done for State regulatory purposes with respect to EIA are available. While the EIA results are biased, they represent an index of disease change. These types of data have been found to be far superior to information which had been previously collected from practicing veterinarians on a routine basis by means of postcard-type questionnaires (Beal, 1980b).

The meaning of this finding is that statistically sound data is preferred for purposes of determining disease incidence and loss per animal. The author has heard and read the statement, (Morris, 1980 and 1982) and (Meek and Morris, 1981), that decision-type statistical methods are more useful in animal disease analysis than are classical experimental-type statistical methods. This statement ignores the fact that many times when decision-type statistical methods are used, the components of the analysis have been obtained by means of classical experimental methods. Research work has been conducted at the University of Minnesota on methods of improving animal disease data for purposes of determining disease incidence (Diesch and Martin, 1979).
Combining Loss Per Animal And Incidence Or Prevalence Of Disease

Once one has obtained estimates of loss per animal and incidence of the disease, the two estimates must be combined in order to obtain an overall estimate of the loss due to the disease. This was not too much of a problem for diseases such as brucellosis and TB in cattle but was a big problem in EIA and would be a big problem in anaplasmosis and bluetongue. One must ask the question as to what is the relationship between serological disease and clinical disease. This is the case whether one is dealing with a test which has good specificity and sensitivity, as with anaplasmosis and EIA, or if one is dealing with a disease where they may not be a good relationship between serological and clinical disease, as may be the case with bluetongue.

Projection Of Year-To-Year Incidence, Prevalence, and Losses

Mathematical or statistical modeling has been used in the estimation of losses under various alternative programs, and with no program. This type of estimation has perhaps given the greatest amount of trouble. Most VS analyses have examined one or two alternatives to having no program. Three methods have been used to project future trends, either of disease spread or of program progress. These are linear regression of logarithmically (log) transformed historical data, simplistic or pseudo epidemiological models, and true epidemiological models.

In order to use linear regression of past results to project into the future, one must have data which, when plotted on probability or semi-log graph paper, will follow essentially a straight line. Also the conditions affecting disease change should be the same for both the past and future. As mentioned above, it was found that program testing results for brucellosis and TB were poor measures of prevalence. When the data were plotted on semi-log, probit, or other appropriate graph paper, results were quite erratic.

The U.S. has had slaughter inspection of livestock for many years. One of the conditions included in inspection is that of TB in cattle. When one plotted TB slaughter data for 1925 to 1965, brucellosis milk ring test results for 1955 to 1964, and market cattle brucellosis testing results for 1967 to 1971, one obtained plots which were rather straight. This was an indication that in terms of year-to-year trends, these were better measures of incidence than were area testing results. This problem has been discussed in greater detail by the author (Beal, 1980a).

As mentioned above, this type of information is a useful measure of progress toward eradication in cost-benefit analyses as long as the conditions affecting progress remain the same and the data remains free of bias. However, neither of these conditions continued to hold. With respect to bovine TB in the late 1960's, the prevalence of TB became so low that TB-like conditions caused by other organisms outnumbered TB-caused conditions at slaughter. This meant that slaughter data had reduced
utility as an index of the infection rate. This is an example of the problem of lack of specificity.

In performing analyses of ongoing programs, one must compare projected future progress with what would happen in the future if the program was discontinued. With respect to TB, slaughter data existed for the period prior to the start of the program in 1917. It was felt that one might be able to use this data to predict the future infection rate without a program. However, this gave a slow rate of increase, and it was felt that with the greater herd sizes of today, the disease would spread much faster now than it did from 1900 to 1917. Consequently, linear regression of past data was inadequate in modeling TB. This led later to the use of epidemic modeling for TB and other diseases.

HISTORY OF ANALYSES IN VETERINARY SERVICES

Analyses have been done on programs for screwworms, sheep scabies, bovine brucellosis, bovine TB, cattle fever ticks, and cattle scabies. Analyses have also been done on proposed or potential programs for trichinosis, Mycoplasma gallisepticum, mastitis, swine TB, EIA, and bont ticks in Puerto Rico.

These analyses are listed in Table 1 with the benefit-cost (B-C) ratio,

<table>
<thead>
<tr>
<th>Program or Disease Analyzed</th>
<th>Year</th>
<th>Type of Model</th>
<th>B-C Ratio</th>
<th>Quality</th>
<th>Principal Analyst</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screwworm</td>
<td>1967</td>
<td>None</td>
<td></td>
<td>Average</td>
<td>Staff</td>
</tr>
<tr>
<td></td>
<td>1975</td>
<td>None</td>
<td>20 to 1</td>
<td>Average</td>
<td>Staff</td>
</tr>
<tr>
<td>Brucellosis</td>
<td>1967</td>
<td>None</td>
<td></td>
<td>Poor</td>
<td>Staff</td>
</tr>
<tr>
<td></td>
<td>1975</td>
<td>Double Bin⁴</td>
<td>5 to 1</td>
<td>Very Good</td>
<td>Kryder/Staff</td>
</tr>
<tr>
<td></td>
<td>1976</td>
<td>Triple Bin</td>
<td>8 to 1</td>
<td>Excellent</td>
<td>Kryder/Beal</td>
</tr>
<tr>
<td>Sheep Scabies</td>
<td>1967</td>
<td>Single Bin</td>
<td>16 to 1</td>
<td>Poor</td>
<td>Staff</td>
</tr>
<tr>
<td>Trichinosis</td>
<td>1967</td>
<td>Simple</td>
<td>1 to 1</td>
<td>Average</td>
<td>Staff</td>
</tr>
<tr>
<td>M. gallisepticum (Turkeys)</td>
<td>1967</td>
<td>Regression</td>
<td>12 to 1</td>
<td>Average</td>
<td>Staff</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chickens</td>
<td>26 to 1</td>
<td>Average</td>
<td>Staff</td>
</tr>
<tr>
<td>Mastitis</td>
<td>1968</td>
<td>Simple</td>
<td>4 to 1</td>
<td>Good</td>
<td>McCallon</td>
</tr>
<tr>
<td>Cattle Fever Ticks</td>
<td>1969</td>
<td>Double Bin</td>
<td>99 to 1</td>
<td>Good</td>
<td>Staff</td>
</tr>
<tr>
<td>Bovine TB</td>
<td>1969</td>
<td>Double Bin</td>
<td>4 to 1</td>
<td>Good</td>
<td>Kryder/Roswurm</td>
</tr>
<tr>
<td>Scrapie</td>
<td>1969</td>
<td>Double Bin</td>
<td>1 to 1</td>
<td>Average</td>
<td>Kryder/Staff</td>
</tr>
<tr>
<td>Cattle Scabies</td>
<td>1976</td>
<td>Double Bin</td>
<td>27 to 1</td>
<td>Very Good</td>
<td>Kryder/Staff</td>
</tr>
<tr>
<td>EIA</td>
<td>1975</td>
<td>Simple</td>
<td>0.3 to 1</td>
<td>Average</td>
<td>Staff</td>
</tr>
<tr>
<td>Swine TB</td>
<td>1975</td>
<td>Simple</td>
<td>2 to 1</td>
<td>Average</td>
<td>Staff</td>
</tr>
<tr>
<td>Bont Ticks</td>
<td>1978</td>
<td>Simple</td>
<td>2 to 1</td>
<td>Average</td>
<td>Kryder</td>
</tr>
</tbody>
</table>

⁴The type of model was the responsibility of V. C. Beal, Jr.

Quality depends upon knowledge of disease and population at risk.

Bin is the abbreviation for binomial.
approximate year and quality of analysis, and principal analyst. The quality of each analysis was rated by the author and depended largely upon what was known about the epidemiology of the disease and the population of animals under attack by the disease. "Bin" is the abbreviation for binomial.

The type of model, if any, is also shown in Table 1. It was due to problems with a cost-benefit analysis of sheep scab that led to the use of binomial based epidemiological models. As mentioned above, it was due to the inadequacy of a previous analysis of bovine TB that led to the development of more complete models for animal disease programs. Also, as mentioned above, this inadequacy was in the projection of TB slaughter results prior to 1917.

**EPIDEMIC OR ANIMAL DISEASE MODELS FOR PURPOSES OF C-B ANALYSIS**

Epidemic or animal disease models have been important to the success or lack of success in performing valid cost-benefit analyses in Veterinary Services (VS). Experiences in VS in performing these analyses, along with observations of certain other analyses, have led the author to classify epidemic or animal disease models into two classes. The first class is true-epidemic models and the second class is pseudo-epidemic models (Beal 1980a).

The basis of this classification is whether the model relates properly to epidemiological factors which affect the magnitude of the disease. This includes their effect on the probability of buying infected animals. Some factors are: (1) the structure of the population at risk; (2) the contagious nature of the disease; (3) the incubation period of the disease; (4) the expected extent of the disease within an infected herd or flock; (5) the size of herd or flock; (6) the amount of movement from herd to herd; (7) the amount of movement from one geographical region to another; and (8) the effect of types of management which either lead to a dead end or intensify the disease.

This list of factors is by no means complete whereas Table 2 gives a much more complete list of 33 factors. The factors used in an analysis will depend upon the extent of knowledge of the factors. It must be emphasized at this point that these discussions of true-epidemic models apply strictly to diseases that are spread from herd-to-herd by the movement of infected animals.

**The Difference Between True- And Pseudo-Epidemic Models**

**The True-Epidemic Model:** The true-epidemic model is one that is capable of making use of or relating to the above and other epidemiological factors including their effect upon the probability of buying infected animals. The only model which has been found that qualifies is the double binomial. It has been modified into the stratified triple binomial, and as such has been used very successfully in the analysis of bovine brucellosis.
ANIMAL DISEASE PROGRAM EVALUATION

programs by U.S. and Canadian animal disease authorities. The best analyses in VS have made use of various modifications of the double binomial. Table 2 gives a list of factors which have been modeled with the various binomial analyses.

The Pseudo-Epidemic Model: The pseudo-epidemic model is one which cannot make rational use of, or relate to the various factors affecting the disease including their effect on the probability of buying infected animals. The pseudo-epidemic model has two subgroups. One subgroup has rational parameters, while the other subgroup has abstract parameters (Beal 1980a).

Unfortunately, one must often resort to pseudo-epidemic models in doing cost-benefit analysis due to lack of existing scientific knowledge of the disease and/or the population of animals under attack by the disease. In doing this, one must try to use rational parameters and avoid using unsound estimates of the parameters or making other unsound assumptions.

The Use Of Epidemic Models In Veterinary Services

True Epidemic Models: One of the first cost-benefit analyses in VS, as shown in Table 1, was for sheep scabies. In performing this analysis, an attempt was first made to utilize historical data by the use of regression analysis in order to estimate losses with and without a program. However, this was found to be unsatisfactory, just as previously had been the case with bovine TB. Since the spread of a disease such as sheep scabies is highly dependent upon the movement of infected animals, it was decided to construct a disease spread model.

Methods from the literature including Bailey (1957) were found to be highly unsatisfactory. Since spread of disease tends to be related to flock size, the sheep population was stratified by flock size. The simple binomial was used in order to estimate probabilities. The parameter “p” in the binomial represented the proportion of flocks which were infected, while the parameter “n” represented the number of flocks from which animals were purchased. The probability of purchasing animals from infected flocks for each flock size group was then estimated.

There were two problems with this effort. The first was that by use of the simple binomial, one assumed that 100 percent of the animals in an infected flock were infected and capable of spreading the disease when sold into an uninfected flock. The second was that it was known that a disease of the nature of bovine brucellosis, bovine TB, or sheep scabies tends to approach an upper limit and level out. This did not happen with use of the simple binomial model.

The author had been introduced to the double binomial by his predecessor, J. U. McGuire, Jr. (1963). McGuire had developed this methodology for purposes of calculating the probability of detecting TB in an infected cow when multiple TB tests were performed. This double binomial has a second binomial within the first binomial.
As used in modeling disease spread, the parameters of the second binomial represent the proportion of animals which are infected within the infected herd, and the number of replacement animals which are purchased from each herd (Beal, 1980a). This particular form was used in analyses of cattle fever tick, bovine TB, cattle scabies, scrapie, and bovine brucellosis programs from 1969 to 1975.

Various problems were inherent in these analyses using the double binomial. One major problem was that animals which are sold for replacement purposes frequently have a lower infection rate than do adult animals in the infected herd. A second major problem was that herds in range areas tend to have a lower infection rate than herds in non-range areas. The double binomial was modified into the triple binomial in handling the replacement versus adult problem, while the population was stratified by regions in handling the range versus non-range problem. There originally was stratification only for herd size and beef versus dairy.

To date, there has been one analysis by VS (Beal and Kryder 1977), two by the Canadian animal health officials (Agriculture Canada 1979a and 1979b), and one by Texas A&M University (Amosson et al. 1978) with these changes. This last analysis was done for the National Brucellosis Technical Commission. Amosson et al. are currently doing a followup study for VS.

It must be emphasized that the double and triple binomial is a demanding methodology in that it requires extensive knowledge of the factors included in the model. However, no methodology is of value without proper estimates of the parameters, and it remains that the double and triple binomial is the only present method that has appeared that relates adequately to the various epidemiological factors of concern in performing analyses.

**Pseudo-Epidemic Models:** Pseudo-epidemic models were used in VS for cost-benefit analyses of trichinosis, *M. gallisepticum*, mastitis, EIA, swine TB, and bont ticks. Most of these analyses used rational parameter type pseudo-epidemic models. Pseudo-epidemic models were used for each of these analyses due to the nature of the disease and the lack of knowledge about the disease and the population at risk.

**Evolution of the Triple Binomial Methodology:** Table 2 shows the evolution of the use of the simple, double, and triple binomial models in VS and at Texas A&M University. The headings at the top of this table give the series of analyses done with the various forms of the binomial methodology. The first column heading refers to the sheep scab analysis. The next column heading shows analyses done with the regular double binomial. Both the sheep scab analysis and the regular double binomial analyses had stratification by herd size. The last three columns refer to the analyses which were expanded to the regionally stratified double or triple binomial.
Table 2. Epidemiological Factors Modeled for the Various Single, Double, and Triple Binomial Stratified Herd Analyses.

<table>
<thead>
<tr>
<th>Epidemiological Factors</th>
<th>1967</th>
<th>70 M bov.</th>
<th>70 Scrap.</th>
<th>75 C Scab</th>
<th>1976</th>
<th>1978</th>
<th>1983</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability of Buying Infected Animals</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Proportion of Herds Infected</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Number of Source Herds</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Lone Binomial, 100% Inf’n in Herd,</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Double &amp; Triple Binomials Allow For,</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>Organized Cleanup</td>
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<td>-</td>
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<td>X</td>
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</tr>
<tr>
<td>Adjacent Herd Testing</td>
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</tr>
<tr>
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<td>Deadend Herd Stratification</td>
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<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Closed Herd Stratification</td>
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<td>-</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

The sub-heading 1976 APHIS refers to the 1976 brucellosis analysis done using the triple binomial. The Canadian Animal Health officials also did two analyses using the same computer program. The sub-heading 1978 NBTC refers to the analysis done by the Agriculture Economics Department of Texas A&M (T-A&M) University for the National Brucellosis Technical Commission (NBTC). The sub-heading 1983 T-A&M refers to a followup analysis to the NBTC analysis currently being done for Veterinary Services.
The column at the left of this table lists the various factors that have been modeled with the various binomial analyses. The section on the triple binomial gives an idea of its purpose. Its purpose is also discussed in several papers on the double binomial. The X’s and -’s in the body of the table indicate whether the various factors were modeled for each type of analysis. An “X” indicates that the factor was modeled while a “-” indicates that the factor was not modeled.

It will be seen that 4 factors were modeled for the sheep scab analysis, 8 factors for the regular double binomial analyses, 21 factors for the 1976 APHIS analysis, 18 factors for the 1978 NBTC analysis, and that 30 factors are being modeled for the current Texas A&M analysis. The 33 possible factors listed in this table do not exhaust the number of factors that might be modeled. It must be emphasized that there should be sound information on the factors that are actually modeled.

The triple binomial methodology was used very successfully by the Canadian Animal Health Officials for studies of brucellosis and tuberculosis completed respectively in October and March 1979. They reported at meetings in 1981 and 1982 that there is remarkable correspondence between the number of infected herds simulated in the depopulation option and the number actually found for the two and three years since the two analyses.

Function of the Various Factors in the Triple Binomial Methodology: The function of each of the various epidemiologic and population factors that are shown in Table 2 is shown in Table 3. Two of the four functions involve the probability of buying infected replacement animals while the other two involve either inter-herd or intra-herd infection rates.

The epidemiologic and population factors involving the probability of buying infected replacement animals do so in two different ways. Some involve the algebra of computation directly while some involve differences in the algebraic values among the various strata. Those factors that involve the algebra of computation directly do so by having a component in the algebraic formula for each factor while some factors will have differing values for a specific algebraic component depending upon such strata as herd size and region of the country.

Many of the epidemiologic and population factors affect either inter-herd or intra-herd infection rates and hence affect the probability of buying infected animals indirectly by affecting the values of certain of the double or triple binomial algebraic components. Some of the factors involve more than one of these functions as shown in Table 3.

It is the ability of the triple and double binomial methodology to make rational use of these various factors in the computation of the probability of buying infected animals that makes the double and triple binomial models true epidemic models. It is also the failure of the various methodologies that will be discussed in the next section to make rational use of these various factors in computing the probability of buying infected animals that make those methodologies pseudo-epidemic models.
Other Epidemiological Models

**General Comments:** Various other epidemiological models have been encountered. They include state-transition or chain-binomial models, linear programming models, and Australian Monte Carlo models. In general, these models fail to relate to the appropriate epidemiological and population factors affecting the probability of inter-herd spread of the disease.

<table>
<thead>
<tr>
<th></th>
</tr>
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<tbody>
<tr>
<td><strong>Epidemiological Factors</strong></td>
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<td></td>
</tr>
<tr>
<td>Probability of Buying Infected Animals</td>
</tr>
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<td>All 3 Binomial Methods Include,</td>
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<td>Proportion of Herds Infected</td>
</tr>
<tr>
<td>Number of Source Herds</td>
</tr>
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<td>Lone Binomial, 100% Inf'n in Herd</td>
</tr>
<tr>
<td>Double &amp; Triple Binomials Allow For,</td>
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<tr>
<td>Less than 100% Infection in Herd</td>
</tr>
<tr>
<td># of Replacements per Source Herd</td>
</tr>
<tr>
<td>Third Binomial Change Repl't Inf'n,</td>
</tr>
<tr>
<td>Infectiousness of Replacements</td>
</tr>
<tr>
<td>Age Difference in Repl'ments</td>
</tr>
<tr>
<td>Quarantined Herds</td>
</tr>
<tr>
<td>1st Concentration Point Testing</td>
</tr>
<tr>
<td>Vaccine Effect in Initiating Inf'n</td>
</tr>
<tr>
<td>Incubating Infection in Repl'ments</td>
</tr>
<tr>
<td>Stratify by Herd Size</td>
</tr>
<tr>
<td>Stratify by Year of Herd Infection</td>
</tr>
<tr>
<td>Stratify by Dairy and Beef</td>
</tr>
<tr>
<td>Natural Cleanup</td>
</tr>
<tr>
<td>Stratified by Region (Management)</td>
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<tr>
<td>Regional Purchase Probability</td>
</tr>
<tr>
<td>Fence or Neighborhood Spread</td>
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<td>Vaccine Effect on Inf'n Rate in Herd</td>
</tr>
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<td>MCI Detection and Efficiency</td>
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<td>BRT Detection and Efficiency</td>
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<td>Organized Cleanup</td>
</tr>
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<td>Depopulation</td>
</tr>
<tr>
<td>First Point Testing Effect on MCI</td>
</tr>
<tr>
<td>Increase Traceability</td>
</tr>
<tr>
<td>Increase Number Tested</td>
</tr>
<tr>
<td>Differential Cull Rate for MCI</td>
</tr>
<tr>
<td>Stratify Quarantined Herds</td>
</tr>
<tr>
<td>Residual Infection</td>
</tr>
<tr>
<td>Area Testing</td>
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<td>Adjacent Herd Testing</td>
</tr>
<tr>
<td>Epidemiological Testing</td>
</tr>
<tr>
<td>Post Quarantine Testing</td>
</tr>
<tr>
<td>Vaccine Level Stratification</td>
</tr>
<tr>
<td>Deadend Herd Stratification</td>
</tr>
<tr>
<td>Closed Herd Stratification</td>
</tr>
</tbody>
</table>
particular disease being analyzed. Consequently, these models fall into
the class of pseudo-epidemic models.

**State-Transition or Chain-Binomial Models:** The first epidemic
models were developed for human disease. Bailey (1957) describes some of
them in a text. The Reed–Frost chain binomial model, which is mentioned
by Bailey, was one of the first such models and was developed by Reed and
Frost at Johns Hopkins University.

This model was modified into a state-transition or Markov chain-
binomial model which was used in modeling foot-and-mouth disease else-
where (Miller, 1979). The modified model has a single parameter called the
contact or dissemination rate. This parameter fails to relate at all to the
various epidemiological factors affecting the spread of disease. Conse-
quently, it falls into the class of pseudo-epidemiological models (Beal
1980a).

**Linear Programming Models:** Linear programming (LP) has been
used in conducting animal disease analyses. It is mandatory that there be
adequate knowledge of the values to be used in such analyses. Multiple
regression analysis of VS program data has been used elsewhere to obtain
values for an LP analysis of the California Brucellosis Program (Carpenter
and Howitt, 1978). These values were then used as parameters in the LP
analysis.

Unfortunately, the variables in the multiple regression analysis were so
badly confounded with each other, that when this is considered together
with the bias in the reactor animal data, it is questionable whether valid
values were obtained for use in the LP analysis (Beal 1980a). In addition,
the multiple regression analysis of past data does not allow for changed
conditions such as those of herd sizes different from those that existed in
the past or different methods of infected herd detection, etc. It also will not
allow for the examination of new program alternatives which have not
been tried in the past.

Consequently, the LP model as used for this purpose falls into the
category of a pseudo-epidemic model. This criticism of LP is in contrast to
the availability of sound data for the sound use of LP in computing
least-cost feed rations. It had been planned that a part of the current
brucellosis study at Texas A&M University would involve the use of
values from the triple binomial and values obtained from program data in
conducting an LP analysis of farmer strategies towards the disease in
order to provide an idea of the utility of LP in animal disease analysis.
However, this part of the study has been canceled.

**Australian Monte Carlo Models:** Models which simulate differences
among animals within herds for specific diseases have been developed in
Australia and are called Monte Carlo models. These Monte Carlo models
do this by simulating the life cycle of the individual animals within the
herd or flock.

One of these Monte Carlo models has been developed for bovine bru-
cellosis (Roe, 1977). This particular analysis has been reported upon in
various places. An examination of the Ph.D. thesis by Roe reveals that this model has parameters which fail to validly account for inter-herd spread of the disease. Consequently, it falls into the pseudo-epidemic model category. There are several other parameters that enhance this model's pseudo-epidemic model characteristics.

Another Monte Carlo model has been developed for ovine fascioliasis. This model (Meek and Morris, 1981) was developed on the basis of data from flocks of sheep on irrigated and non-irrigated pastures. An examination of the paper by Meek and Morris on this model has revealed a poor statistical correlation for the liver fluke burden between simulated results and field results for the irrigated pastures with correlation coefficients of 0.62 and 0.51 for two different years.

Despite this poor correlation, it was stated that this model could be used to evaluate various control strategies. However, there is no documentary data given for this claim. There needs to be information showing how a model developed under one set of circumstances performs in duplicating the results of controlled field studies conducted under various other sets of circumstances. This should include rigorous multiple correlation analysis.

In addition, it is questionable whether results could be obtained from such an effort that would equal the results from a well constructed multiple regression model based upon the same data which is used to construct the Monte Carlo model. This Monte Carlo model should also be classified as a pseudo-epidemic model based upon the available evidence.

Epidemic Modeling And The Effect Of Herd Size

One of the major failures of the epidemiological models discussed in the above section is that of not being able to account for the effect of herd size upon the extent of a disease. The double and triple binomial is the only methodology that has been found that can do this.

The results of two simulations with the double binomial illustrate this effect of herd size on infection level. These two simulations treat the United States as one homogeneous population involving the dairy and beef cow populations separately and were carried out for 40 years. Some of the results are shown in Tables 4, 5, 6, and 7. Summary results for the 40th year are shown in Tables 4 and 5 while results for individual years are shown in Tables 6 and 7. Results are further shown for dairy cattle in Tables 4 and 6 and for beef cattle in Tables 5 and 7.

It can be seen from Tables 4 and 5 that a larger proportion of the large herds are infected than of the small herds. This observation of herd size differences was confirmed by studies that have been done and are being done at Texas A&M University where a tabulation of actual infected dairy and beef herds for the United States for the years 1976 and 1978 showed the same general difference among herd size groups.

Results of selected years from 0 to 40 which show the pertinent yearly trends are shown in Tables 6 and 7 for dairy cattle and beef cattle respectively. An examination of these two tables reveals that the large
### Table 4. Number of Infected Dairy Herds in the 40th Year for Each of 8 Herd Size Groups.

<table>
<thead>
<tr>
<th>Herd Size</th>
<th>Proportion of Herds Infected</th>
<th>Total Herds</th>
<th>Infected Herds</th>
<th>Clean Herds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 4</td>
<td>0.030</td>
<td>126,382</td>
<td>3,833</td>
<td>122,549</td>
</tr>
<tr>
<td>5 to 9</td>
<td>0.107</td>
<td>38,900</td>
<td>4,153</td>
<td>34,747</td>
</tr>
<tr>
<td>10 to 19</td>
<td>0.190</td>
<td>82,030</td>
<td>15,607</td>
<td>66,423</td>
</tr>
<tr>
<td>20 to 29</td>
<td>0.273</td>
<td>73,216</td>
<td>19,991</td>
<td>53,225</td>
</tr>
<tr>
<td>30 to 49</td>
<td>0.352</td>
<td>84,118</td>
<td>29,627</td>
<td>54,491</td>
</tr>
<tr>
<td>50 to 99</td>
<td>0.452</td>
<td>38,467</td>
<td>17,387</td>
<td>21,080</td>
</tr>
<tr>
<td>100 to 199</td>
<td>0.562</td>
<td>7,368</td>
<td>4,138</td>
<td>3,230</td>
</tr>
<tr>
<td>200+</td>
<td>0.652</td>
<td>2,486</td>
<td>1,622</td>
<td>864</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>452,967</td>
<td>96,358</td>
<td>356,609</td>
</tr>
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</table>

### Table 5. Number of Infected Beef Herds in the 40th Year for Each of 8 Herd Size Groups.

<table>
<thead>
<tr>
<th>Herd Size</th>
<th>Proportion of Herds Infected</th>
<th>Total Herds</th>
<th>Infected Herds</th>
<th>Clean Herds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 9</td>
<td>0.168</td>
<td>237,991</td>
<td>39,997</td>
<td>197,994</td>
</tr>
<tr>
<td>10 to 19</td>
<td>0.357</td>
<td>233,800</td>
<td>83,457</td>
<td>150,343</td>
</tr>
<tr>
<td>20 to 29</td>
<td>0.467</td>
<td>172,342</td>
<td>80,458</td>
<td>91,884</td>
</tr>
<tr>
<td>30 to 49</td>
<td>0.556</td>
<td>179,985</td>
<td>100,075</td>
<td>79,910</td>
</tr>
<tr>
<td>50 to 99</td>
<td>0.651</td>
<td>137,790</td>
<td>89,681</td>
<td>48,109</td>
</tr>
<tr>
<td>100 to 199</td>
<td>0.725</td>
<td>56,645</td>
<td>41,052</td>
<td>15,593</td>
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<tr>
<td>200 to 499</td>
<td>0.764</td>
<td>23,035</td>
<td>17,604</td>
<td>5,431</td>
</tr>
<tr>
<td>500+</td>
<td>0.777</td>
<td>5,445</td>
<td>4,232</td>
<td>1,213</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1,047,033</td>
<td>456,556</td>
<td>590,477</td>
</tr>
</tbody>
</table>

Herds reach the maximum infection level sooner than the small herds. This same observation was also seen in a sensitivity study entitled "Effect of Herd Size on Spread of Disease." The row labeled "Max" gives the total number of herds in each group while the row labeled "40" gives the number of infected herds in the 40th year.

### Table 6. Single Region Dairy Brucellosis Simulation. Distribution of Infected Herds by Herd Size and Year of Simulation.

<table>
<thead>
<tr>
<th>Year Simulated</th>
<th>1-4</th>
<th>5-9</th>
<th>10-19</th>
<th>20-29</th>
<th>30-49</th>
<th>50-99</th>
<th>100-199</th>
<th>200+</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30</td>
<td>35</td>
<td>50</td>
<td>100</td>
<td>110</td>
<td>160</td>
<td>155</td>
<td>95</td>
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<tr>
<td>2</td>
<td>62</td>
<td>74</td>
<td>281</td>
<td>424</td>
<td>716</td>
<td>570</td>
<td>239</td>
<td>194</td>
</tr>
<tr>
<td>4</td>
<td>162</td>
<td>194</td>
<td>811</td>
<td>1,195</td>
<td>2,063</td>
<td>1,559</td>
<td>563</td>
<td>456</td>
</tr>
<tr>
<td>8</td>
<td>864</td>
<td>1,022</td>
<td>4,260</td>
<td>6,118</td>
<td>10,275</td>
<td>7,282</td>
<td>2,277</td>
<td>1,304</td>
</tr>
<tr>
<td>12</td>
<td>2,243</td>
<td>2,568</td>
<td>10,269</td>
<td>14,017</td>
<td>22,134</td>
<td>14,108</td>
<td>3,681</td>
<td>1,574</td>
</tr>
<tr>
<td>16</td>
<td>3,261</td>
<td>3,620</td>
<td>13,953</td>
<td>18,292</td>
<td>27,666</td>
<td>16,607</td>
<td>4,037</td>
<td>1,613</td>
</tr>
<tr>
<td>20</td>
<td>3,669</td>
<td>4,009</td>
<td>15,185</td>
<td>19,577</td>
<td>29,165</td>
<td>17,208</td>
<td>4,115</td>
<td>1,620</td>
</tr>
<tr>
<td>40</td>
<td>3,833</td>
<td>4,153</td>
<td>15,607</td>
<td>19,991</td>
<td>29,626</td>
<td>17,387</td>
<td>4,138</td>
<td>1,622</td>
</tr>
<tr>
<td>Max</td>
<td>126,382</td>
<td>38,900</td>
<td>82,030</td>
<td>73,216</td>
<td>84,118</td>
<td>38,467</td>
<td>7,368</td>
<td>2,486</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year Simulated</th>
<th>1-4</th>
<th>5-9</th>
<th>10-19</th>
<th>20-29</th>
<th>30-49</th>
<th>50-99</th>
<th>100-199</th>
<th>200+</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30</td>
<td>35</td>
<td>50</td>
<td>100</td>
<td>110</td>
<td>160</td>
<td>155</td>
<td>95</td>
</tr>
<tr>
<td>2</td>
<td>62</td>
<td>74</td>
<td>281</td>
<td>424</td>
<td>716</td>
<td>570</td>
<td>239</td>
<td>194</td>
</tr>
<tr>
<td>4</td>
<td>162</td>
<td>194</td>
<td>811</td>
<td>1,195</td>
<td>2,063</td>
<td>1,559</td>
<td>563</td>
<td>456</td>
</tr>
<tr>
<td>8</td>
<td>864</td>
<td>1,022</td>
<td>4,260</td>
<td>6,118</td>
<td>10,275</td>
<td>7,282</td>
<td>2,277</td>
<td>1,304</td>
</tr>
<tr>
<td>12</td>
<td>2,243</td>
<td>2,568</td>
<td>10,269</td>
<td>14,017</td>
<td>22,134</td>
<td>14,108</td>
<td>3,681</td>
<td>1,574</td>
</tr>
<tr>
<td>16</td>
<td>3,261</td>
<td>3,620</td>
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<td>18,292</td>
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<td>16,607</td>
<td>4,037</td>
<td>1,613</td>
</tr>
<tr>
<td>20</td>
<td>3,669</td>
<td>4,009</td>
<td>15,185</td>
<td>19,577</td>
<td>29,165</td>
<td>17,208</td>
<td>4,115</td>
<td>1,620</td>
</tr>
<tr>
<td>40</td>
<td>3,833</td>
<td>4,153</td>
<td>15,607</td>
<td>19,991</td>
<td>29,626</td>
<td>17,387</td>
<td>4,138</td>
<td>1,622</td>
</tr>
<tr>
<td>Max</td>
<td>126,382</td>
<td>38,900</td>
<td>82,030</td>
<td>73,216</td>
<td>84,118</td>
<td>38,467</td>
<td>7,368</td>
<td>2,486</td>
</tr>
</tbody>
</table>
Table 7. Single Region Beef Brucellosis Simulation. Distribution of Infected Herds by Herd Size and Year of Simulation.

<table>
<thead>
<tr>
<th>Year Simulated</th>
<th>Size of Herd</th>
<th>1-9</th>
<th>10-19</th>
<th>20-29</th>
<th>30-49</th>
<th>50-99</th>
<th>100-199</th>
<th>200-499</th>
<th>500+</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>6,672</td>
<td>8,956</td>
<td>8,152</td>
<td>8,497</td>
<td>6,521</td>
<td>6,262</td>
<td>3,148</td>
<td>1,187</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>9,848</td>
<td>19,553</td>
<td>21,096</td>
<td>29,240</td>
<td>32,526</td>
<td>21,946</td>
<td>12,676</td>
<td>4,195</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>20,111</td>
<td>47,287</td>
<td>51,867</td>
<td>72,886</td>
<td>76,874</td>
<td>41,114</td>
<td>19,018</td>
<td>4,683</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>32,716</td>
<td>75,704</td>
<td>78,674</td>
<td>103,521</td>
<td>97,099</td>
<td>44,820</td>
<td>19,003</td>
<td>4,542</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>40,519</td>
<td>89,136</td>
<td>88,063</td>
<td>110,245</td>
<td>97,606</td>
<td>43,629</td>
<td>18,404</td>
<td>4,393</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>43,946</td>
<td>93,069</td>
<td>89,482</td>
<td>109,902</td>
<td>96,309</td>
<td>43,199</td>
<td>18,303</td>
<td>4,376</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>45,368</td>
<td>93,849</td>
<td>89,138</td>
<td>108,894</td>
<td>95,446</td>
<td>42,918</td>
<td>18,206</td>
<td>4,355</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td>39,997</td>
<td>83,457</td>
<td>80,458</td>
<td>100,074</td>
<td>89,681</td>
<td>41,052</td>
<td>17,604</td>
<td>4,232</td>
</tr>
<tr>
<td>Max</td>
<td></td>
<td>237,991</td>
<td>233,800</td>
<td>172,342</td>
<td>179,985</td>
<td>137,790</td>
<td>56,645</td>
<td>23,035</td>
<td>5,445</td>
</tr>
</tbody>
</table>

As mentioned above, both of these examples on the effect of herd size assume that the United States is one homogenous region. Consequently, they do not give a completely realistic picture of what would happen for the United States as a whole. However, they do provide a realistic picture of the effect of herd size, both in terms of the herd size distribution existing in a particular population and in terms of different herd size distribution populations.

Sensitivity Studies

In doing any type of epidemiological modeling, it is important that sensitivity studies be conducted for various values used in the model. For instance, in conducting the Veterinary Services (VS) analysis of the U.S. Bovine Brucellosis Program, various sensitivity studies were performed. These included differences in herd size for dairy cattle, and in culling rates and market testing rates for beef cattle. These results have been reported in two memorandums entitled “Effect of Herd Size on Spread of Disease” and “Market Cattle Test Program as an Efficient Surveillance Tool.”

The sensitivity study of the effect of herd size on the spread of disease examined the difference in spread of disease in using the dairy herd size distributions for 1954 and 1969 for the United States. There was an increase in the proportion of large herds and a decrease in the proportion of small herds. The simulation showed that the infection increased faster and reached a plateau earlier with the 1969 herd size distribution as compared to the 1954 herd size distribution.

Information contained in the sensitivity study of the market cattle test program provided important insights into various other factors involved in the spread and control of brucellosis. This analysis and the ones on the effect of herd size were made possible due to the nature of the double binomial methodology. It would not have been possible to have done these analyses with any of the various pseudo-epidemic models which have been mentioned.

However, it must be emphasized that certain limited sensitivity studies can be done with pseudo-epidemic models. Certainly, this has been the
KNOWLEDGE REQUIRED FOR COST-BENEFIT ANALYSES

Necessary components of training and/or knowledge for a team performing valid cost-benefit analyses of national animal disease control and/or eradication programs are illustrated in Table 8. A wide breadth of knowledge in most team members rather than knowledge in a single discipline will result in a smaller team being necessary to accomplish the analysis. The resulting smaller team will have fewer communication problems and a better analysis will be the result. The best analyses in VS had all five veterinary components of knowledge including a veterinary economist plus animal husbandry and a biometrician. This permitted a proper understanding of the various factors involved in the disease and host population plus a valid mathematical formulation of these factors.

Table 8. Components of Training and/or Knowledge for Performing Valid Cost-Benefit Analyses of National Animal Disease Programs.

<table>
<thead>
<tr>
<th>Component</th>
<th>Necessary/Desirable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Veterinary Disease Control Field Operations</td>
<td>Necessary</td>
</tr>
<tr>
<td>2. Veterinary Disease Control Budget Planning</td>
<td>Necessary</td>
</tr>
<tr>
<td>3. Veterinary Specific Disease Knowledge</td>
<td>Necessary</td>
</tr>
<tr>
<td>4. Veterinary Epidemiology</td>
<td>Necessary</td>
</tr>
<tr>
<td>5. Animal Husbandry of Host Species</td>
<td>Necessary</td>
</tr>
<tr>
<td>6. Biometrician</td>
<td>Necessary</td>
</tr>
<tr>
<td>7. Veterinary Economist or Agricultural Economist</td>
<td>Necessary</td>
</tr>
<tr>
<td>8. Veterinary Economist Plus Agricultural Economist</td>
<td>Desirable</td>
</tr>
</tbody>
</table>

SOME FINAL THOUGHTS

From work with a graduate student in the development of cost-benefit analysis for foot-and-mouth disease in a developing country (Arambulo 1977), and from work with diseases where information is lacking in the U.S., it has become evident to the author that all countries should be extremely cautious in applying cost-benefit analysis, even when they have a sound information system for obtaining basic animal disease data.

Epidemic modeling is not a panacea, and will not serve as a substitute for sound information. In addition, cost-benefit analysis can only be as sound as the basic information which is available for use. Without availability of sound information for epidemic modeling and for cost-benefit analysis in general, this procedure will serve only to confuse the decision process rather than to enlighten it.

REFERENCES


INTRODUCTION

In 1983 APHIS Veterinary Services initiated two pilot studies of the proposed National Animal Disease Surveillance (NADS) system. Through the respective offices of the State Veterinarians, Ohio and Tennessee are cooperating in these studies which are being conducted by district Veterinary Medical Officers (VMO's), APHIS Technical Staff, and faculty and staff of the two state Colleges of Veterinary Medicine. The NADS objective is valid and practical inference concerning the incidence and prevalence of disease and conditions which have economic and public health impacts. An equally important objective is estimation of the magnitude of these impacts.

We present here a brief description of the NADS statistical random sampling and data collection plans which will lead to valid population inferences. We further describe the use of pilot studies in the development and implementation of these plans.

THE PROPOSED PLAN

The Ohio and Tennessee pilot studies are limited to dairy, beef and hog herds. Additional species such as sheep may be included as pilot studies expand. Sampling frames or lists will be developed which will give every eligible herd in the state a chance of being drawn. The frame will be stratified into VMO districts. This form of geographical stratification is known to be correlated with differences in husbandry practices throughout each State. Within each reporting district or strata a designed statistical random sample of herds will be drawn using such techniques as multistage cluster and probability proportional to size sampling.

Each VMO will have a list of randomly drawn target herds from which he must locate and recruit cooperators in the NADS. Each cooperator will sign a contract requiring maintenance of an extensive and detailed herd health record which will be recalled, reviewed and transcribed during monthly visits by the district veterinarian working on the NADS project. If a recruitment attempt is unsuccessful, demographic data on the farmstead will be recorded and next alternative on the list will be drawn.

A monthly animal inventory will be taken on each farmstead recruited and it is this count of animals under surveillance which will be used to form denominators in estimates of incidence, prevalence, and per capita costs.

*Departments of Applied Statistics and Large Animal Clinical Sciences, University of Minnesota.
Anonymity of submitted herd reports will be built into the data accumulation procedures.

From time to time and as need arises the panel of cooperating farmsteads will be subsampled. These subsampled farmsteads will be investigated intensively and with the cooperation and involvement of the local practitioner. The structured subsample will have immediate inference to the entire sample which will, in turn, have inference to the designated population.

GOALS OF THE PILOT STUDIES

The pilot studies will yield understanding of costs and feasibility. The experience in "cold" recruitment of randomly designated producers will be used in estimation of the costs of drawing observations. Such knowledge of costs is essential to the calculation of optimal allocations of effort and the statistical efficiency of various choices of sampling plans. In the pilot phases an investigation is being conducted into the availability and efficiency of various sampling frames. These population lists are an essential prerequisite to the NADS sampling plan and are generally costly or laborious to accumulate.

The pilot study experience will be used to develop the administrative procedures needed for a reliable and efficient flow of information to a compiling center. In particular, the pilot studies are expected to determine what information is accessible to trained professional veterinarians making monthly visits and what information must be collected using intensive investigations on subsamples. The practical aspects of maintaining cooperators' anonymity will also be developed.

The pilot studies are not expected to produce data leading to immediate publication of reasonably precise estimates. However, the pilot studies are expected to produce reliable indications of sample sizes and funding levels need for such estimation.

THE PILOT PROGRAM

Ohio has 15 reporting districts and Tennessee has 10. The field investigator in each district will recruit one dairy, two beef, and one hog herd. Using information in their list frame the Statistical Research Service (SRS) of USDA has supplied the NADS pilot project with distributions of herd sizes by county. In each of these 25 districts this information is being used to draw a county with probability proportional to the size of its species population. In a drawn county the county agent's office is cooperating in supplying a list of producers having herds in a certain size range (eg. 10–49 milk cows) specified by the technical staff. From this list the names of a producer and subsequent alternates are drawn with equal probability. Table 1 contains the distribution of animals in herd sizes and the distribution of sampled herd sizes.
Pilot study reporting forms have been designed to allow administrative comments from the field investigators and the cooperating producers. All returned forms are being read by the NADS project technical staff.

Three-day planning and orientation sessions were held in September 1983 and first review sessions are planned for mid-Winter in 1984.

### Table 1. Sample distributions of herd sizes.

<table>
<thead>
<tr>
<th>Herd Size</th>
<th>Population</th>
<th>Sampled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-9</td>
<td>7%</td>
<td>1</td>
</tr>
<tr>
<td>10-49</td>
<td>35%</td>
<td>5</td>
</tr>
<tr>
<td>50-99</td>
<td>38%</td>
<td>6</td>
</tr>
<tr>
<td>100+</td>
<td>19%</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

### DAIRY

<table>
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<th>Population</th>
<th>Sampled</th>
</tr>
</thead>
<tbody>
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<td>1-9</td>
<td>7%</td>
<td>1</td>
</tr>
<tr>
<td>10-49</td>
<td>34%</td>
<td>4</td>
</tr>
<tr>
<td>50-99</td>
<td>34%</td>
<td>3</td>
</tr>
<tr>
<td>100+</td>
<td>25%</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

### BEEF

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<th>Population</th>
<th>Sampled</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-49</td>
<td>33%</td>
<td>10</td>
</tr>
<tr>
<td>50-99</td>
<td>26%</td>
<td>8</td>
</tr>
<tr>
<td>100-149</td>
<td>19%</td>
<td>6</td>
</tr>
<tr>
<td>150+</td>
<td>22%</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>30</td>
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### HOGS

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<th>Population</th>
<th>Sampled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-9</td>
<td>1%</td>
<td>0</td>
</tr>
<tr>
<td>10-99</td>
<td>35%</td>
<td>4</td>
</tr>
<tr>
<td>100-249</td>
<td>33%</td>
<td>3</td>
</tr>
<tr>
<td>250+</td>
<td>31%</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

NADS PILOT STUDIES

(350,000 in 15,000 herds)  (290,000 in 12,600 herds)

<table>
<thead>
<tr>
<th>Herd Size</th>
<th>% of Herds</th>
<th>Herd Size</th>
<th>% of Herds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-9</td>
<td>7%</td>
<td>1-9</td>
<td>7%</td>
</tr>
<tr>
<td>10-49</td>
<td>35%</td>
<td>10-49</td>
<td>34%</td>
</tr>
<tr>
<td>50-99</td>
<td>38%</td>
<td>50-99</td>
<td>34%</td>
</tr>
<tr>
<td>100+</td>
<td>19%</td>
<td>100+</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>

(1,400,000 in 33,000 herds)  (1,700,000 in 55,000 herds)

<table>
<thead>
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<th>% of Herds</th>
<th>Herd Size</th>
<th>% of Herds</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-49</td>
<td>33%</td>
<td>10-49</td>
<td>49%</td>
</tr>
<tr>
<td>50-99</td>
<td>26%</td>
<td>50+</td>
<td>51%</td>
</tr>
<tr>
<td>100-149</td>
<td>19%</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>150+</td>
<td>22%</td>
<td></td>
<td>30</td>
</tr>
</tbody>
</table>

(1,200,000 in 9,000 herds)  (1,300,000 in 28,000 herds)

<table>
<thead>
<tr>
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<th>% of Herds</th>
<th>Herd Size</th>
<th>% of Herds</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-499</td>
<td>44%</td>
<td>1-9</td>
<td>1%</td>
</tr>
<tr>
<td>500+</td>
<td>56%</td>
<td>10-99</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>100-249</td>
<td>33%</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>250+</td>
<td>31%</td>
</tr>
</tbody>
</table>

Table 1. Sample distributions of herd sizes.
THE INTERFACE BETWEEN THE MINNESOTA FOOD ANIMAL DISEASE REPORTING SYSTEM AND THE APHIS 5-PHASE PLAN

By Stanley L. Diesch, DVM

In development of the pilot National Animal Disease Surveillance system (NADS), careful consideration was given to the positive and negative evaluations of more than 10 years experience of the Minnesota Food Animal Disease Reporting System (MFADRS). In this paper similarities and differences of ORGANIZATION, STATISTICAL RANDOM SAMPLE, CONFIDENTIALITY, PAYMENT TO THE FARMER FOR REPORTING, LENGTH OF PARTICIPATION TIME OF REPORTING FARMER AND DEVELOPING ECONOMIC INFORMATION of the two systems MFADRS and NADS will be discussed.

ORGANIZATION

MFADRS

Since MFADRS began in 1971, the organization was a combined effort of many individuals and organizations. Included in this effort were the Minnesota Board of Animal Health, USDA, APHIS, Veterinary Services, the Minnesota Veterinary Medical Association, the College of Veterinary Medicine, Department of Applied Statistics, the Computer Center, University of Minnesota and livestock producers.

NADS

This has been developed with a broad base of input and effort. USDA, APHIS, Veterinary Services has taken a national leadership role in development and implementation. This is a cooperative effort with states. Within each State, the State veterinarians and Federal veterinarians assigned to states will have a major role in conducting the system. Randomly selected farmers will participate in this system directly with State-Federal veterinarians. The local private veterinary practitioner identified by the reporting farms will have a significant part in establishing diagnosis of disease on their clients' farms.

Justification

Under MFADRS, a voluntary system, private practitioners participated effectively in obtaining monthly reporting information from their clients farms. However, there appears to be variation among states and regions as to how often livestock producers call a private practitioner. Definitive information on this subject is not available.

District veterinarians, many of whom had previous experience in private veterinary practice, together with their extensive regulatory experience are expected to be very capable in collecting of information under NADS. This surveillance effort will increase their professional
responsibility and importance within each state and the nation. Because of these efforts they will become a major component together with private practitioners, veterinary diagnostic laboratories and meat inspection in the detection and resolution of problems associated with domestic and foreign animal diseases.

In Minnesota, District veterinarians had expressed some concern that their surveillance efforts on farms who are clients of practicing veterinarians would result in antagonism from the private practitioner. It is my opinion that if there is adequate communication with the practitioner, that this will not occur. In general regulatory veterinarians have good rapport with practitioners.

In 1981, one year following the validation study of MFADRS the 10 practitioners selected at random and participating in the validation study were surveyed. The following is one of the results that the survey determined: "If a client of yours was randomly drawn to participate in a state disease reporting system for 6 months, and you were informed of his participation by a regulatory veterinarian who would gather the data via monthly visits to the farmstead, would you as a private practitioner object to this approach as a reporting method?"

YES 0 NO 10

STATISTICAL RANDOM SAMPLE

MFADRS

In 1971 this system began with selected veterinarians who were asked to report on 15 farms, which were selected from a list of farms that the practitioner identified that he could get along with.

In succeeding years, this list was reduced to 5 farms selected in the above procedure. Later the practitioners used the first 3 calls of the month as reporting farms for that month. This latter procedure was utilized as the practitioner sample in the validation study. This procedure resulted in reporting of higher morbidity and mortality rates than occurred from a statistical random sample visited monthly by a field veterinary epidemiologist.

During the validation study 60 farms were selected in a 13 county area in Southern Minnesota. Dairy cattle and hog farms were selected, although all 60 farms named a private practitioner, some never called a veterinarian during the study year. Although, the number of farmers that routinely call veterinarians is unknown, the method of randomly selecting farms will include information from farms that never or rarely call a veterinarian. The 60 farm validation project constituted a statistical random sample and likely included some farmers that never called a veterinarian, but all named a practitioner that they call.
NADS

In the 1983 pilot states of Ohio and Tennessee, lists of farms with animals are being obtained from the County Extension Directors. These lists appear adequate, but in the future, it may be possible to obtain more complete lists from the Statistical Research Service.

At present it is projected that this constitutes a reliable randomized sample.

Justification

With farmers in and out of livestock production, with people moving or changing occupations, it is difficult to retain a total sample frame of all existing livestock production. However, a statistical random sample results in inclusion of selected farms that may never call a veterinarian. This sample will have less bias than, for example, selecting only dairy cattle under Dairy Herd Improvement Testing. For meaningful data continued efforts must be made to collect information from a statistical randomized sample.

CONFIDENTIALITY

MFADRS

Every effort was made to assure the confidentiality of the reporting farmer. Each participating farmer was given a coded number, so that his identification was only known to his private veterinary practitioner. Later, when the pilot study was being conducted the field epidemiologist went directly to the farms for surveillance information and was the only person knowledgeable of the farmers location. We also have limited experience on VMO's going directly to the farms for surveillance information in three districts in northern Minnesota.

NADS

Every effort is being made to protect the confidentiality of the reporting farms by identification of each farm with a coded number. Exceptions are being made where potential exotic foreign diseases of animals may occur. The contract agreement between the farmer and the state for 15 months of reporting and surveillance addresses confidentiality.

Justification

For implementation of the program, the reporting farmers must be assured that confidentiality will prevail. However, there must be an understanding that if a foreign disease is suspected that confidentiality be waived in support of resolution of the potential problem. Each farmer should be asked to identify a private practicing veterinarian. Permission should be obtained from the farmer to be able to communicate with this practitioner for further eliciting the diagnosis and being able to relate to him surveillance information obtained from his client. To obtain the most
reliable information, a triangular relationship must be established; the veterinary medical officer, the practicing veterinarian and the livestock owner.

PAYMENT TO THE FARMER FOR REPORTING

MFADRS

Prior to the validation study in 1979–1980 farmers or practicing veterinarians were not paid for reporting. The program was totally voluntary. During the validation study, each of the 60 cooperating farmers received $25.00 per month for a period of one year, with a payment of $300.00 at the completion of the reporting. It was our experience that this payment and developing a contract greatly enhanced their cooperative efforts in reporting.

NADS

Each farmer will report to the VMO by contractual agreement to participate. For this effort the farmer will be paid $25.00/month or a total of $375.00 at the conclusion of the 15 months of reporting effort.

Justification

Minnesota experienced excellent cooperation from the farmers reporting during the validation of MFADRS. Of the 60 farmers selected in the 13 county area all signed a contract to participate for one year. The concept of some payment is reasonable and logical. The farmer received a portion of wages for time spent in filling in forms and general information.

The 60 farmers participating in the validation test were surveyed. The results were:

Would you recommend that a livestock producer should be paid for the endeavor of reporting the animal diseases and conditions on his farm?

YES 42   NO 11

LENGTH OF PARTICIPATION TIME OF REPORTING FARMER

MFADRS

In 1971 the farmers and their practicing veterinarians were asked to report for one year. Later the time was reduced to 6 months. In a later phase they reported for only one month. In Minnesota, especially during the one year validation study it was determined that it required two or three months for the farmer to become properly indoctrinated into the use of the forms and guidelines to report valid information.

NADS

A decision was made to enter into a contract for 15 months. This would
allow three months to become accustomed to the forms and guidelines and to dedicate one year of meaningful reporting.

**Justification**

The consensus is that 15 months will allow a year or more of meaningful information. Continuation of the time would possibly develop biases in the system.

**DEVELOPING ECONOMIC INFORMATION**

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Efforts were primarily dedicated to develop methods for obtaining disease morbidity and mortality information. Limited efforts were made to obtain economic information but this information has not been published.

**NADS**

Economic and production information is being obtained from each farm. This effort has been designed by agricultural and veterinary economists. This includes data concerning veterinary calls, drugs and vaccines, vaccination costs, and losses due to morbidity such as loss of weight (stunting), and mortality.

**Justification**

Economic information is essential to document the effect of disease and preventive measures on production of animals.

This information is needed:

- a) by veterinarians practicing preventive medicine in planning prevention strategies
- b) by regulatory veterinarians to justify, develop, and implement new control and eradication programs
- c) to indicate and justify needed areas of research
- d) by pharmaceutical and biologics companies in planning new product development
- e) by livestock producers in assessing cost-benefit analyses. The result is more efficient agricultural production benefiting farmers and consumers

This will enhance prevention, control and eradication of diseases and subsequently improve livestock management and production.
ANIMAL DISEASE REPORTING IN MEXICO
Jorge Vargas Levaro D.V.M.
Benjamin Jara Guillen D.V.M.(*)

INTRODUCTION

We would like to explain what we have been doing in Mexico during the last twelve years in animal health surveillance. In order to understand a surveillance system that is linked to the Federal Government, it is necessary to have a general view of the public administration of Mexico. We are living in a federal system, with 32 states and a central federal district. The central government is divided into three branches; the Executive, the Legislative, and the Judicial. Authority is centralized. The Executive, formed by the President, has 18 departments; one of these is the Agriculture and Hydraulic Resources Department. It is divided into three divisions; one of these is the Livestock Division, which is further divided into twelve units. The Animal Health Unit is in charge of the "National System of Epizootiology Information." Our system has undergone continual modifications due to the changes in the public administration. In 1968, the Agriculture Department stated the need to develop a "National Network of Diagnostic Laboratories" for animal diseases. The purpose was to collect information on infectious diseases including incidences and prevalences. Equally important was the establishment of programs for prevention, control and possible eradication of animal diseases.

SYSTEM DEVELOPMENT

The number of laboratories was increased from 8 in 1970 to 100 in 1982. The laboratories were the base for collecting animal disease data, providing a free diagnostic service to animal owners, private veterinary practitioners, and to other government services. As a result, a manual system of animal disease reporting was developed and called "The Laboratory Information System." It was the only resource for making inferences on animal health from 1969 to 1976 and had serious deficiencies for interpretation and analysis. It was a uniform, monolithic system covering the entire country.

In 1977, to decentralize the public administration, the Animal Health Division was restructured. In addition, a large computer system was installed in the central office. As a result, the Animal Disease Report was modified.

CURRENT STATUS

The disease reporting system, named "Sistema de Informacion Epizootiologico" (SIEP), has three levels; the field level, the state level and the central level.

The field level includes laboratory data, controlled animal diseases data, outbreak data, federal field veterinary data, and animal health extension data.

(*) Director of Animal Health, Agriculture and Hydraulic Resources Department, Mexico
At the state level (32 states and one federal district), there is an animal health coordinator who is in charge of centralization, accumulation, and compilation of animal health data produced in each field division. In addition, they produce the planning data on prevention, control, and extension of health programs.

At the central level, data from the state level is compiled and analyzed by the computer system in the Office of Epizootiology Analysis. The office produces a monthly report titled “The Bulletin of Animal Health” which is sent to government veterinarians, private practitioners, universities, and international agencies. This bulletin currently reports the new cases of thirty animal diseases, including geographical location, and the number of animals tested, as well as the results, under each of the ten current control campaigns.

**DATA QUALITY**

Diagnostic laboratories, eradication campaigns, and slaughterhouse data represent biased samples of animal health problems in the total animal population for many reasons and are therefore not statistically valid random samples for statistical inferences. Producer participation in eradication campaigns is voluntary for most diseases. Other data depends on the interests of animal owners and private veterinarians. Slaughterhouse data depends on the visual interpretation and diagnosis by official veterinarians at the time of slaughter. In addition, animal disease requiring official quarantine are sometimes not reported.

Nevertheless, the accumulated data has given us valuable information on trends, geographical distribution of acute diseases, and monetary losses due to disease outbreaks. This information has been useful in planning control and eradication campaigns for Venezuelan encephalitis, rabies, hog cholera, and others.

Recent modifications have been introduced into the animal disease reporting system to better locate new outbreaks of animal disease, including exotic diseases outside of known endemic areas. A method of location by quadrants using latitude and longitude of meridians and parallels has been devised to replace the use of state boundaries as locators. This method may be very useful at an international level. Describing location by state, county, town or farm presents a severe problem to people who need to pinpoint a disease occurrence but who are not familiar with local ambiguous nomenclature.

At the field level, two hundred federal veterinarians are collecting randomized samples for those animal diseases which are economically important in their respective work area. This new procedure was implemented in 1981. So far the data has been collected but not completely analyzed for IBR, brucellosis, and hog cholera. The importance of each disease and its inclusion in the sampling was determined by interviews with private practitioners, animal owners, and by the number of people
hospitalized for zoonotic infections in each area. In Mexico, differences in disease prevalence and severity between areas depend greatly on climate, topography, and management because there is a wide difference in environment and technology between areas. These veterinarians receive training in proper sample collection, data collection, analysis and interpretation. With these measures, we are trying to assure that data quality and quantity are adequate for proper epidemiological interpretation and action.

In 1982, reforms in animal health laws were implemented, making obligatory and compulsory the reporting of all exotic, foreign and certain animal diseases under control programs. This mandate includes all the persons involved in the livestock industry, including animal owners, private veterinarians, animal technicians, animal breeders, animal importers, and institutions.

**FUTURE OBJECTIVES**

In the future, we need to further develop the system of surveillance to give us information useful for evaluation of epizootological, economic and social impacts of each important disease in order to justify and to implement programs of animal disease control. We need to determine which diseases have the greatest impact in order to properly allocate our monetary and human resources.

The Minnesota surveillance system represents a new approach because it involves the animal owner and private practitioner in the information reporting system in addition to utilizing state and federal veterinarians who conduct surveillance on a statistical random sample of farmsteads. There must be benefits important to all involved for the system to function adequately. In addition, the system also gathers information on environmental, economic, and management conditions which are very important in the assessment of animal disease incidence, impact, and control. Mexico and the United States both need to develop surveillance systems that provide information useful on an international basis to prevent the introduction of undesirable diseases into animal populations and to promote trade.
REPORT OF THE COMMITTEE ON MORBIDITY AND MORTALITY

Chairman: G. C. Poppensiek, Ithaca, NY
Vice Chairman: C. P. Combs, San Juan, Puerto Rico (Acting Chairman)
Committee Members: J. A. Acree, MD; F. J. Alderink, MD; R. K. Anderson, MN; V. C. Beal, Jr., MD; Douglas L. Berndt, DC; S. L. Diesch, MN; J. G. Flint, MN; M. E. Hugh-Jones, LA; N. E. Hutton, OR; J. L. Hyde, MD; R. F. Kahrs, MO; L. J. King, MD; Larry Mark, VA; Frank Martin, MN; W. R. McCallon, MD; E. H. McCauley, MT; H. A. McDaniel, MD; W. R. Miller, AL; L. G. Morehouse, MO; R. S. Morris, MN; Phyllis B. Mullenax, MD; T. G. Murnane, Mexico, DF; J. C. New, TN; S. R. Nusbaum, NJ; E. I. Pilchard, MD; J. C. Prucha, MD; Philip Ross, DC; Leon Russell, TX; Vaughn A. Seaton, IA; G. H. Snoeyenbos, MA; C. D. Van Houweling, VA

The vice-chairman called the meeting of the Committee on Morbidity and Mortality Reporting of Food Animal Diseases to order at 1:30 p.m. Thursday, October 20, 1983.

The following four papers were presented and are enclosed as a part of the Committee Report.

Dr. Lonnie J. King: An overviewing of the APHIS 5-Phase plan for food-animal disease surveillance; a progress report.

Dr. Stanley L. Diesch: The interface between the Minnesota Food Animal Disease Surveillance System and the APHIS 5-phase plan.

Dr. Frank Martin: Random sampling procedures for pilot projects.

Dr. Jorge Vargas Levaro & Dr. Benjamin Jarg: Animal Disease Reporting in Mexico.

In addition to the above papers, Dr. Ingvar Ekesbo, Professor of Veterinary Medicine from Skara, Sweden summarized for the Committee the Swedish Animal Disease Surveillance System.

The subcommittee report of Drs. Nusbaum, Russell and Hughes was presented and is attached to the committee report. The acting chairman of the committee expressed appreciation to the members of the subcommittee for their efforts.

The Committee was gratified to note that APHIS had started a Pilot Study in Ohio and Tennessee in September 1983. Three papers were presented to the Committee which discussed this activity and future plans.

The Committee encourages APHIS to review and consider for future utilization, information available from Veterinary Diagnostic Laboratories and Food Safety Inspection Service. It appears this information will be most useful when subsampling of the National Animal Disease Surveillance System is started.

A discussion occurred on how to obtain lists to select a statistically valid random sample. Limitation and expenses of several alternatives were discussed and it would appear that either the Statistical Reporting Service...
MORBIDITY AND MORTALITY

list frame will be used or that APHIS and the states will have to develop their own by alternative procedures.

One resolution concerning changing the name of the Committee to the Committee on Animal Disease Surveillance was moved, discussed and passed unanimously and was sent to the Resolution Committee for consideration.

NATIONAL ANIMAL DISEASE SURVEILLANCE: STATUS REPORT FOR MORBIDITY AND MORTALITY COMMITTEE, USAHA

In September of this year, State and Federal Veterinary Medical Officers (VMO's) from Ohio and Tennessee and two university veterinarians (Ohio State University and the University of Tennessee) were involved in training activities to implement the Animal and Plant Health Inspection Service (APHIS) pilot project for National Animal Disease Surveillance (NADS). This represents the beginning of the next stage of the APHIS 5-phase program for NADS that was introduced at the USAHA meeting in 1981 and unanimously supported by this committee.

This is a major step which takes NADS off the "drawing board" and into the realities for which it must be tested. The NADS system is moving ahead in its plan to develop the methodology for assessing incidence, prevalence, trends, and the economic impact of diseases of domestic livestock. The project is concerned with valid data collection and its unbiased interpretation. Surveillance based on statistically sound requirements and random selection of herds allows for valid estimates and inferences to be made for entire populations at risk.

In the pilot States, surveillance will be limited to beef cattle, dairy cattle, and hog operations. Farms are randomly selected and stratified by size and production unit through the use of the Statistical Reporting Service (SRS) frequency distribution tables and the use of lists supplied by county extension agents. Each participating livestock producer, who will be used for a period of 15 months, will be paid $25 a month for his services. The field veterinarian will visit each of his four assigned farmsteads on a monthly basis. The veterinarian and farm cooperator will closely monitor the selected herds and help account for all disease occurrences and economic costs associated with the disease conditions.

Forms have been designed for enumerating and analyzing pertinent data. The VMO and livestock cooperator will assess the herd health status and give clinical impressions of disease and health related conditions. Once this broad-range health assessment is done, a statistically significant subsample will be needed for making more precise, laboratory confirmed diagnoses to define specific disease causes. There are, of course, diseases which result in subclinical or inapparent infections. As we learn more about these disease entities, it is apparent that such infections may actually result in economic losses which have not been previously considered. Therefore, indepth diagnostic workups involving the diagnos-
tic laboratories are essential and are seen as playing a vital role in this activity. The formation of a national serum bank is also envisioned as a worthwhile effort in a NADS system.

In many instances herds selected for surveillance activities will be serviced by private practitioners. The VMO will work closely with the veterinary practitioner to help assess an accurate herd health picture. The VMO's who collect the data will never function as, or supplant, the private practitioner. When treatments or services are needed or requested, the VMO will always recommend the use of a local practitioner.

It will be necessary to continuously refine the methodology for collecting and analysing the on-farm data. We anticipate several years of work and the addition of more States into the pilot program before meaningful data can be generated. In FY'84, three additional States will be included in the project. In FY'85, we may double this effort. It is mandatory to assure that high quality and unbiased data is collected before the use of either computer-generated information or sophisticated techniques such as modelling is considered; however, the use of such technology is seen as an important future objective.

Close and continuous contact with the 25 veterinarians collecting the on-farm data is an essential function. Evaluation meetings will be held in Ohio and Tennessee after 2-3 months' data has been collected. These ongoing evaluations will help refine our methodology. The forms coming from the field will be closely examined by Federal, State, and university personnel. The pilot project is a learning experience for everyone, and many changes will be made as we design a workable system.

The need for a statistically reliable national animal disease system has never been greater. In the past the livestock diseases of concern have been the highly visible, major epizootics. The prevalence of many of these diseases has been substantially reduced or eliminated; yet, despite these advances, production losses have remained high. New, emerging diseases are on the horizon. Modern production and marketing practices, and intensive methods of animal husbandry may be responsible for an increase in animal diseases due to environmental and genetic factors. Diseases are being recognized as very complex syndromes that require more sophisticated diagnostic techniques and also require us to collect significant data to learn about these diseases. We must utilize new techniques to collect and evaluate data and assess disease prevalence, trends, and economic losses on a State, regional and national level. Effective control of animal diseases can be achieved only by basing decisions and programs on accurate up-to-date information, which is currently unavailable.

An effective system of animal health surveillance will require information to be gleaned from the collection of statistically and scientifically valid data. This will allow the livestock industry to accurately define its disease problems and their economic significance. Partial or complete elimination of these losses will increase the quality and supply of animal protein, reduce their cost to the consumer, conserve energy resources, and
increase export potential.

Current data on animal diseases are fragmented, nonadditive, and not statistically valid. This situation is unacceptable for a nation whose livestock industry produces food and fiber second to none. The cost of animal diseases to producers has been estimated to be between $4 and $6 billion annually. However, in truth, without a statistically reliable national animal disease surveillance system, no one can know for certain.

There would appear to be little disagreement as to what information is needed, but the methodology to secure this information is more controversial. Historically, several unsuccessful attempts have been made to acquire basic information on implementing a NADs system. Hopefully, we can learn from past mistakes; those previous experiences will be helpful in developing a new NADs system.

APHIS has been designated as the lead agency to develop methodology which will provide estimates on disease prevalence, incidence, trends, and economic costs. To be successful in this endeavor, it will need the cooperation of other government agencies, such as the Agricultural Research Service, the Statistical Reporting Service, the Food Safety and Inspection Service, and the Extension Service. The support of other groups is also essential, such as: State departments of agriculture, diagnostic laboratories, practicing veterinarians, colleges of veterinary medicine, and especially livestock owners and their associations. APHIS intends its role in a NADs system to be one of a coordinator and facilitator of an integrated effort, which will be based on the cooperation between many veterinary and agribusiness professions. Consultants and advisors also are necessary. A liaison council which will include members of the livestock industry and veterinary specialists will be implemented soon. Appropriate seminars will be held with all cooperating groups in order to explain the NADs system.

Today's budgetary realities necessitate the most cost-effective use of public funds. The more that is known about animal diseases, the better State and Federal agencies can plan their programs. A NADs system will allow APHIS to accommodate many potential beneficiaries who, by themselves, cannot collaborate and marshal resources on a national basis.

As we expand the pilot and develop the proper methodology to reach our objectives, we will be calling on many groups for input and assistance, including members of this committee. Mistakes will be made, and we acknowledge that many questions remain unanswered at this time. However, it is time to move ahead and leave the academic arguments and any self-serving special interests behind us. We must have a visionary outlook, yet be practical and perceptive in our methods and carefully scrutinize our implementation plans for a NADs system. There are many people looking over our shoulder, and the contribution of this committee will be reflected in planning future events.
The Interface Between the Minnesota Food Animal Disease Reporting System and the APHIS 5-Phase Plan

By Stanley L. Diesch, DVM

In development of the pilot National Animal Disease Surveillance system (NADs), careful consideration was given to the positive and negative evaluations of more than 10 years experience of the Minnesota Food Animal Disease Reporting System (MFADRS) System. In this paper similarities and differences of ORGANIZATION, STATISTICAL RANDOM SAMPLE, CONFIDENTIALITY, PAYMENT TO THE FARMER FOR REPORTING, LENGTH OF PARTICIPATION, TIME OF REPORTING FARMER, AND DEVELOPING ECONOMIC INFORMATION of the two systems MFADRS and NADs will be discussed.

ORGANIZATION

MFADRS

Since MFADRS began in 1971, the organization was a combined effort of many individuals and organizations. Included in this effort were the Minnesota Board of Animal Health, USDA, APHIS, Veterinary Services, the Minnesota Veterinary Medical Association, the College of Veterinary Medicine and Department of Applied Statistics, the Computer Center, University of Minnesota and livestock producers.

NADs

This has been developed with a broad base of input and effort. USDA, APHIS, Veterinary Services has taken a national leadership role in development and implementation. This is a cooperative effort with states. Within each State, the State veterinarians and Federal veterinarians assigned to states will have a major role in conducting the system. Randomly selected farmers will participate in this system directly with State-Federal veterinarians. The local private veterinary practitioner identified by the reporting farms will have a significant part in establishing diagnosis of disease on their clients farms.

Justification

Under MFADRS, a voluntary system, private practitioners participated effectively in obtaining monthly reporting information from their clients farms. However, there appears to be variation among states and regions as to how often livestock producers call a private practitioner. Definitive information on this subject is not available.

District veterinarians, many of whom had previous experience in private veterinary practice, together with their extensive regulatory experience are expected to be very capable in collecting of information under NADs. This surveillance effort will increase their professional responsibility and importance within each state and the nation. Because of these efforts they will become a major component together with private prac-
tioners, veterinary diagnostic laboratories, and meat inspection in the
detection and resolution of problems associated with domestic and foreign
animal diseases.

In Minnesota, District veterinarians had expressed some concern that
their surveillance efforts on farms who are clients of practicing veterinari-
ans would result in antagonism from the private practitioner. It is my
opinion that if there is adequate communication with the practitioner,
that this will not occur. In general regulatory veterinarians have good
rapport with practitioners.

In 1981, one year following the validation study of MFADRS the 10
practitioners selected at random and participating in the validation study
were surveyed. The following is one of the results the survey determined:
"If a client of yours was randomly drawn to participate in a state disease
reporting system for 6 months, and you were informed of his participation
by a regulatory veterinarian who would gather the data via monthly visits
to the farmstead, would you as a private practitioner object to this ap-
proach as a reporting method?"

<table>
<thead>
<tr>
<th>YES</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>10</td>
</tr>
</tbody>
</table>

STATISTICAL RANDOM SAMPLE

MFADRS

In 1971 this system began with selected veterinarians who were asked to
report on 15 farms, which were selected from a list of farms that the
practitioner identified that he could get along with.

In succeeding years, this list was reduced to 5 farms selected in the above
procedure. Later the practitioners used the first 3 calls of the month as
reporting farms for that month. This latter procedure was utilized as the
practitioner sample in the validation study. This procedure resulted in
reporting of higher morbidity and mortality rates than occurred from a
statistical random sample visited monthly by a field veterinary epidemi-
ologist.

During the validation study 60 farms were selected in a 13 county area
in Southern Minnesota. Dairy cattle and hog farms were selected, al-
though all 60 farms named a private practitioner, some never called a
veterinarian during the study year. Although, the number of farmers that
routinely call veterinarians is unknown, the method of randomly selecting
farms will include information from farms that never or rarely call a
veterinarian. The 60 farm validation project constituted a statistical
random sample and likely included some farmers that never called a
veterinarian, but all named a practitioner that they call.

NADS

In the 1983 pilot states of Ohio and Tennessee, lists of farms with
animals are being obtained from the County Extension Director. These
lists appear adequate, but in the future, it may be possible to obtain more
complete lists from the Statistical Research Service.

At present it is projected that this constitutes a reliable randomized sample.

**Justification**

With farmers in and out of livestock production, with people moving or changing occupations, it is difficult to retain a total sample frame of all existing livestock production. However, a statistical random sample results in inclusion of selected farms who may never call a veterinarian. This sample will have less bias then, for example, selecting only dairy cattle under Dairy Herd Improvement Testing. For meaningful data continued efforts must be made to collect information from a statistical randomized sample.

**CONFIDENTIALITY**

**MFADRS**

Every effort was made to assure the confidentiality of the reporting farmer. Each participating farmer was given a coded number, so that his identification was only known to his private veterinary practitioner. Later, when the pilot study was being conducted the field epidemiologist went directly to the farm for surveillance information and was the only person knowledgeable of the farmers location. We also have limited experience on VMO’s going directly to the farms for surveillance information in three districts in northern Minnesota.

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The 60 farmers participating in the validation test were surveyed. The results were:

Would you recommend that a livestock producer should be paid for the endeavor of reporting the animal diseases and conditions on his farm?

YES 42 NO 11

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a) by veterinarians practicing preventive medicine in planning prevention strategies
b) by regulatory veterinarians to justify, develop, and implement new control and eradication programs
c) to indicate and justify needed areas of research
d) by pharmaceutical and biologics companies in planning new product development
e) by livestock producers in assessing cost-benefit analyses. The result is more efficient agricultural production benefiting farmers and consumers

This will enhance prevention, control and eradication of diseases and subsequently improve livestock management and production.

REPORT OF SUBCOMMITTEE ON REPORTABLE DISEASES

S. R. Nusbaum, (Chairman), D. E. Hughes and L. Russell

The Subcommittee to prepare a model list of reportable diseases prepared and distributed a survey to state veterinarians in an attempt to a) define the present status of reportable diseases in the states and b) seek ideas on which to build a model. Forty states responded. The survey and a compilation of the answers to the first four questions is attached.

The total number of conditions (including those for horses, dogs, cats and mink) was 116. The terminology was in some cases archaic, imprecise or in
other ways inconsistent with present day usage.

While some regulations are quite precise in listing diseases, others are quite broad, frequently generalizing, and requiring the reporting of, e.g. "any other disease condition which may seriously threaten the welfare of the livestock industry." One state utilizes disease conditions listed in the Code of Federal Regulations, Title 9.

A large number of respondents evaluated their present system as "useful" to "very effective." The Subcommittee felt that the opinions expressed a high level of cooperation by clinicians but does not seem to bear useful scrutiny if one examines the number of reports of diseases commonly received by state veterinary officers.

The Subcommittee recommended that each state have a modern accurate reporting procedure based in either law or regulation. Formalization in one of these forms assures a firmer foundation in cases of dispute and a standardization which tends to be useful in interstate and state-federal matters.

As a matter of practicality, it may be useful to have two lists of diseases, one of particular local concern and the other of general interest.
1. Does your state have a list of reportable diseases?
   
<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>7</td>
</tr>
</tbody>
</table>

   1 - "Unofficial list"

   a. If so, are they defined by
      
      | Law | Codified Rules and Regulations | State Veterinarian's Rules |
      |-----|--------------------------------|----------------------------|
      | 14  | 10                            | 17                         |

   b. Can the list be changed easily (without legislative action)?
      
<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>8</td>
</tr>
</tbody>
</table>

2. How useful is the program in identifying and/or controlling disease:
   
<table>
<thead>
<tr>
<th>Very Effective</th>
<th>Effective</th>
<th>Useful</th>
<th>Some Use</th>
<th>Minimally Useful</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>15</td>
<td>11</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

3. What is your estimate of the level of compliance and cooperation by clinicians?
   
<table>
<thead>
<tr>
<th>80-100%*</th>
<th>60-79%</th>
<th>40-59%</th>
<th>20-39%</th>
<th>10-19%*</th>
<th>0-9%</th>
<th>Do Not Know</th>
</tr>
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4. When was the last time the list was updated?
   
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NATIONAL CAGE AND AVIARY BIRD IMPROVEMENT PLAN
STATUS REPORT

N. Marshall Meyers, LL.B.¹

Approximately one year ago during the 86th Annual Meeting of the United States Animal Health Association, Resolution No. 8 was adopted urging the United States Department of Agriculture’s (USDA) endorsement of the proposed National Cage and Aviary Bird Improvement Plan (NCABIP). Since the Nashville meeting, the Subcommittee on the Model State Program for Pet Birds² has held a series of meetings to determine a mechanism for creating and implementing the Cage Bird Plan. This Status Report will briefly review the Plan and the steps necessary for its establishment and implementation.

The Cage Bird Plan was designed as a voluntary, cooperative industry-State-Federal program which would develop minimum standards and provide recognition of those persons participating in the Plan. It provides an opportunity for aviculturists, industry, Federal and State regulators and the scientific community to join together to create a system similar to the extremely successful National Poultry Improvement Plan (NPIP). The Cage Bird Plan would accomplish several objectives important to industry and government alike:

1. It would provide Federal and State governments, as well as Plan participants, standards for interstate and intrastate movement of all avian species, especially those which might be (a) transmitting an exotic disease, and/or (b) illegally imported or traded, such as smuggled, sick, and/or endangered species.

2. It would encourage self-regulation under a State-Federal supervised program regulating animal welfare and husbandry, animal diseases, recordkeeping, and bird identification.

3. It would facilitate Federal and State disease recognition and control, animal welfare, and endangered species programs.

4. It may provide a single, nationwide program to replace the many different programs between States and even within States.

Implementation of the Cage Bird Plan will be no easy task due to the size and scope of the industries involved and the complexity of the issues. Aviculture and the commercial cage bird industry in the United States are substantial. The current aviary and cage bird population ranges between 45,000,000 and 70,000,000 birds residing in 15% to 20% of U.S. house-


²The Subcommittee was established in 1981 by the Committee on Transmissible Diseases of Poultry and Other Avian Species. The Subcommittee is composed of representatives of the U.S. Department of Agriculture, aviculturists, pet shops, bird importers, practicing veterinarians, the poultry industry, and the scientific community.
holds. Pet birds as companion animals are and will continue to be a significant part of our society. Personal collections range from a few common birds to hundreds of breeding pairs of common and exotic species. The value of these birds range from under $5.00 to $10,000 and $12,000 per bird. The commercial cage bird industry is a billion dollar business and is the fastest growing segment in the pet industry.

Outbreaks of avian diseases, especially Viscerotropic Velogenic Newcastle Disease (VVND), pose serious problems not only for the cage bird industry, but also for the poultry industry. As experienced by the 1973 California VVND outbreak, the cost of eradication and control is expensive. That outbreak alone is estimated to have cost the U.S. Government $56,000,000. If VVND were to become established in the United States in 1983, it is estimated that the cost to aviculturists, the cage bird industry and the poultry industry would approximate $500,000,000 annually. Therefore, concerned aviculturists and commercial cage bird interests recognize the necessity of developing a mechanism whereby legitimate operators may deal in cage birds with some assurance that they are dealing in healthy, legitimate specimens and are complying with Federal/State regulations.

The cage bird industry, unlike many industries with which USAHA members deal, is extremely diverse and complex, and the normal distribution channels are virtually non-existent. Consumers can acquire their cage birds directly from each level within the production/distribution chain. As the following chart reflects, each functional segment — importer, breeder, jobber, pet shop and consumer — deals directly with the others. Therefore, the ability to trace the movement of specimens is extremely difficult and costly absent reasonable, uniform recordkeeping and specimen identification requirements.
Existing USDA regulations (9 C.F.R., Part 92), which require the quarantining of imported birds for a thirty day period during which testing is performed to ensure that VVND does not enter the country, work, and work well. 619,751 birds were legally imported during FY83 through the 89 USDA approved quarantine facilities. Substantial numbers of birds are also raised domestically for the trade and hobby. An unknown, but ever increasing number of Central American birds are entering the United States illegally.

USDA's regulations, however, stop at the quarantine door. Once the legally imported birds are released from quarantine, there is little to no mechanism for regulating interstate, let alone intrastate movement. Most states have not adopted rules governing non-native birds other than for endangered species. Thus, illicit trade avoiding quarantine, Customs, Interior's Fish and Wildlife Service inspection, and State regulation, is assisted and benefited by the lack of a uniform, coordinated, Federal and State regulatory mechanism.

In the vast majority of instances in which birds of suspect origin have been detected, neither Federal nor State law provided an adequate mechanism for detaining those birds for the purpose of quarantining and/or testing. The limited regulatory mechanisms which exist are wholly inadequate, contain ambiguous language and conflicting provisions, and make it extremely difficult for those desiring to deal legally in birds to operate within the law. We are faced with a maze of regulations which hinder, not aid, legitimate trade.

Once the Cage Bird Plan is implemented, it will help improve aviculture and the cage bird industry. As mentioned previously, the Plan would be a cooperative industry-State-Federal program through which minimum care and humane standards, uniform documentation (health certificates, recordkeeping), and identification will be adopted by general conferences representing the participating States. The program would be administered by official State agencies in cooperation with USDA. The Federal role, as in the National Poultry Improvement Plan, would be to coordinate and to assist the States in developing and administering the Plan. The States, in conjunction with the participating members, would carry out the day-to-day work of the Plan.

Aviculturists, the commercial cage bird industry, the poultry industry and government agencies need a uniform set of standards which we feel can best be developed and implemented through a voluntary program. Participants would be provided a grace period to come into compliance. Each segment of the commercial industry—importers, breeders, wholesalers/jobbers, retail pet shops, dealers and consumers—would be encouraged to participate. Through the direct involvement of these participants, we hope to foster the development of credible health standards and procedures.
The Cage Bird Plan is designed to be administered at the State level by
the same State agencies responsible for administration of NPIP. General
conferences to review and update the Cage Bird Plan could be held
immediately following NPIP’s General Conferences. This would enable
the most efficient utilization and coordination of expertise.

The Plan would be basically self-supporting with 96% of the funding
coming from the States and member participants and 4% from the Federal
government. It is estimated that the cost to USDA would approximate
$100,000 annually, during the first two years.

Working drafts of proposed regulations to implement the Bird Plan have
been prepared by Subcommittee members and are undergoing continual
revisions. Once approval to proceed has been obtained from USDA, it is
proposed that USDA create a Cage Bird Executive Committee as an
Advisory Committee to finalize recommendations for publication in the
Federal Register as a proposed rulemaking.

A Memorandum of Understanding by and between USDA and each of
the participating States would be prepared and field visits would start
with potential cooperating State agencies. Simultaneously, an effort
would be launched to encourage the establishment of “cage bird improve-
ment associations” in each State.

Initial phases of the Cage Bird Plan would require maintenance of basic
records of acquisitions, sales, hatchings, and losses. Most importantly, an
approved identification system appropriate to the species involved for
those species commonly entering the United States illegally would be
implemented.

Traceability is the key element of the Plan which must be implemented
as expeditiously as possible. Only through adequate identification systems
of those species which are known to be commonly smuggled, such as
Mexican and certain Central American parrots, along with adequate
recordkeeping, is essential to assist Federal and State agencies in en-
suring that VVND does not become established. As the Plan matures, its
various elements will be expanded to involve certification, registries,
directories, improved animal husbandry and coverage of all avian species.

Specific provisions applicable to the operations of an importer, a breeder,
a retailer, a distributor would be adopted with respect to sanitation and
health management programs. These would cover housing, caging, food
and water, nutrition, good housekeeping, isolation of sick birds, density of
birds per cage and per building. Participants demonstrating compliance
with the standards would be entitled to use “U.S. Registered,” “U.S.
Hatched” or some other classification of approval.

Subsequent phases would establish standards for disease recognition,
treatment and control of such contagious and infectious diseases as
VVND, Pox, Pacheco’s disease, Psittacosis, and other avian diseases.
To implement the Plan, a minor amendment to an existing Federal statute (7 U.S.C. §429) will be required to clearly grant the Secretary of Agriculture the necessary authority to proceed. Subcommittee members met with USDA on several occasions during 1982 and early 1983 to ascertain the most feasible method of implementation. The Subcommittee has recommended that USDA utilize a current "Reserved" Part 146, Subchapter F (Poultry Improvement), Chapter 1, C.F.R. Part 146. This Part was formally used for the National Turkey Improvement Plan. It is also proposed that the Cage Bird Plan follow as closely as possible the procedural mechanism previously adopted by the NPIP for purposes of implementation, administration and amendments.

The Subcommittee drafted and circulated a position paper seeking Congressional action to amend 7 U.S.C. §429 to grant the requisite authority to the Secretary of Agriculture to create a Cage Bird Plan by adding the phrase "and other avian species" at the end of Section 429 as follows:

The Secretary of Agriculture is authorized to cooperate with state authorities and with the authorities of the District of Columbia, Alaska, Hawaii, and Puerto Rico in the administration of regulations for the improvement of poultry, poultry products and hatcheries, and other avian species.

Meetings have been held with legislative committee staff members to review the program and the needed statutory amendments. Hopefully, enabling legislation will be introduced and favorable Congressional action taken in the immediate future. Enabling legislation, promulgation of regulations and/or revisions to existing regulations will also be required in many States. All of us concerned with the maintenance of a viable and healthy cage bird community should become involved in this program. A cooperative effort including responsible education programs should assist in implementing the program. At this time the Cage Bird Plan has been endorsed by the following organizations:

American Association of Avian Pathologists
American Federation of Aviculture
Association of Avian Veterinarians
National Poultry Improvement Plan
Pacific Egg and Poultry Association
Pennsylvania Association of Avian Veterinarians
Pennsylvania Poultry Federation
Pet Industry Joint Advisory Council
Southeastern Poultry Association
United States Animal Health Association

We urge Animal Health Officials to be supportive and to work with the aviary cage bird industries within your States. Apathy or anti-cage bird attitudes will be counter-productive. Cage birds are a fungible commodity, easy to transport and secrete, and traceability is virtually impossible without a uniform program such as contemplated in the Cage Bird Plan. It has been well established that total prohibitions or complex legal mecha-
nisms do not deter trade and ownership. Uniformity among the State and Federal government regulations applicable to intrastate and interstate movement will result in effective controls. Through such uniformity, compliance will increase and the threat to public health and safety will be substantially minimized.
REPORT OF THE COMMITTEE ON TRANSMISSIBLE DISEASES OF POULTRY AND OTHER AVIAN SPECIES

Chairman: R.A. Bankowski, California
Vice Chairman: E.T. Mallinson, Maryland

W.W. Adams, GA; T.B. Angel, KY; R.E. Baer, OH; C.W. Beard, GA; S.B. Clubb, FL; M.S. Cover, MO; H.M. Ghori, AR; H.E. Goldstien, OH; E.E. Grass, CA; L.C. Grumbles, TX; R.L. Hogue, IN; I.H. Kahan, PA; D.D. King, MD; T.L. Landers, AR; D.J. Ligda, IN; M. Meyers, DC; R.H. McCapes, CA; T.R. Mickle, GA; M.S. Newman, OK; C.D. Murphy, IL; T.D. Njaka, WV; W.C. Patterson, GA; B.S. Pomeroy, MN; S.S. Richeson, MD; J.A. Smiley, ME; J.W. Thomas, SC; D.N. Tripathy, IL; C.R. Weston, NH.

The committee met at 1:30 p.m., October 18, 1983. Twenty members and 23 guests attended.

NEWCASTLE AND OTHER DISEASES OF IMPORTANCE

Exotic Newcastle Disease and Psittacosis

There were no outbreaks of exotic Newcastle disease (velogenic viscerotropic) Newcastle disease (VVND) in commercial poultry flocks during FY 1983. There were, however, two separate outbreaks involving fighting cock premises near the U.S. Mexican border in Texas. Among exotic birds there were 24 cases of laboratory confirmed VVND in young Yellow-naped Amazon parrots which were believed to have entered the United States illegally. The Federal cost for these outbreaks at the end of the fiscal year was $96,497.

There were 958 cases and 2,930 samples from domestic sources examined at the National Veterinary Services Laboratories (NVSL), Ames, Iowa, for Newcastle disease and 648 cases and 1,585 samples examined for psittacosis. Of the psittacosis specimens, there were 75 cases or 11.6 percent positive for Chlamydia psittaci. There were no reports of C. psittaci infections in poultry in FY 1983.

Avian Influenza

Since April 1983, the diagnostic laboratory at the University of Pennsylvania has been diagnosing avian influenza in chicken flocks in Lancaster County. The NVSL has provided diagnostic referral service for the identification of the numerous outbreaks in the Pennsylvania outbreaks. APHIS has also provided epidemiologic assistance to Pennsylvania in their efforts to control the problem. The report of the avian influenza subcommittee gives a more detailed account of these outbreaks.

Pullorum-Typhoid

There were 64 Salmonella pullorum infections and no Salmonella gallinarum (fowl typhoid) infections during FY 1983 according to an incomplete summary. APHIS has investigated three significant outbreaks of
Pullorum disease, one of which, involved guinea fowl located outside of the Continental United States. Another was a multi state outbreak originating in a breeding flock producing back yard-type red chickens.

The third infection involved a large broiler complex. The source of this infection has not been determined.

**Mycoplasmosis**

Mycoplasmosis infections continues to jeopardize the chicken and turkey industry. *Mycoplasma gallisepticum* infection in turkey flocks was reported in North Carolina, Arkansas, Virginia, and California. None of these infections are believed to have originated from infected turkey breeding flocks.

**PARAMYXOVIRUSES**

The paramyxovirus Evaluation Subcommittee was formed last year because of the increased frequency of isolating paramyxoviruses (PMV), other than Newcastle Disease (NDV), from numerous species of birds and more recently from domestic poultry flocks. In addition, further studies have shown a low level but consistent cross reactions in hemagglutination inhibition (HI) and serum neutralization (SN) tests as well as some cross protection between some PMV (PMV-3) and NDV.

To further complicate matters the paramyxoviruses isolated from avian species have been shown to form at least 9 distinguishable sero-groups which have been designated serotypes PMV-1 to PMV-9 of which NDV is serotype PMV-1. Fortunately, thus far, the paramyxoviruses other than NDV, have not been found to be highly pathogenic for domestic poultry per se. However, numerous reports indicate that synergism with other agents or adverse conditions may result in a complete spectrum of disease varying from high mortalities to minor respiratory distress or egg production problems.

In FY 1983, there were 37 cases with 726 samples submitted to National Veterinary Services Laboratories (NVSL) for PMV serology. There were 5 turkey submissions (12 flocks, 88 samples) positive for antibody against PMV-3. The positive samples were from North Carolina and Minnesota. PMV-3 was also isolated from 9 domestic pet birds.

During the same year, there were 140 PMV-2 and 106 PMV-3 isolates made from imported pet birds that died during quarantine. The isolates were not pathogenic for 4-to-8 week old chickens and turkeys that were inoculated. The subcommittee admitted that it did not know the significance of these viruses in the US, or have a solution, but wishes to alert avian diagnosticians and veterinarians to the potential of the newly recognized group of agents, and to face the challenge of finding means for their prevention and control.

**INFLUENZA**

Since the committee report at the 1982 USAHA there has been a
dramatic change in the prevalence of Influenza in chickens and turkeys. The diagnosis of influenza had decreased in turkeys but since April of 1983 the disease has been diagnosed in at least 38 flocks of chickens in the State of Pennsylvania and in 2 flocks in Maryland.

Avian Influenza in turkeys, during the same period, has been diagnosed in only 2 states. This illustrates that chickens are as vulnerable as turkeys to avian Influenza when conditions are right.

Iowa reported one outbreak (H1N1) in a turkey breeder flock based on sera samples sent to USDA-APHIS-VS.

Minnesota reported outbreaks in the Fall of 1982 involving 24 flocks of turkeys. The serotypes identified were H4N8, H5N2, H6N1, H6N8, H9N2. No new serotypes were identified. Sentinel ducks on lakes at two different locations in an area where avian influenza has been frequently identified in turkeys over the past 10 years revealed infection with 7 different serotypes. H3N6, H4N2, H4N6, H4N8, H6N8, H6N8, H10N5, H12N5. One of the serotypes (H12) has not been identified in turkeys in the United States. The outbreak in chickens in Pennsylvania was first identified in April 1983. Only one serotype has been identified, H5N2. A detailed account of the outbreaks in Lancaster County, Pennsylvania was presented to the group by Dr. R. J. Eckroade of the University of Pennsylvania. He described a disease with a progressive increase in pathogenicity, and spread in broiler, layer, pullet and broiler breeder flocks. Respiratory distress with facial swelling and serosal petechiation of the digestive tract were being observed. Although mortalities of 80 to 90 percent have not been reported, the current situation was extremely fluid and was of great concern to all in attendance.

In view of the spread and increased seriousness of this outbreak, the committee unanimously recommended that: all avian influenza diagnoses in domesticated poultry be considered as a reportable disease and that states develop regulations to allow for quarantine, cleaning, and disinfection.

Use of Influenza Vaccine

During the past year, inactivated Influenza vaccine was used in Colorado, Iowa, Minnesota and Missouri. Approximately 1,100,000 doses were used in approximately 160 turkey flocks.

National Veterinary Services Laboratories

Dr. J.E. Pearson submitted a report concerning Import Quarantine State Isolations (Table 1). No avian influenza isolates were identified in imported birds in FY 1982 and FY 1983. Of the 515 hemagglutinating isolates, almost \( \frac{1}{2} \) (246) have been typed at the time of this report.

REEVALUATION OF NEWCASTLE DISEASE

The subcommittee on reevaluation of Newcastle disease has been in existence for several years and informally discussed possible changes in
Newcastle disease policies. Their report was based on the following facts or beliefs:

1. Existing evidence suggests that velogenic types of Newcastle disease viruses, whether viscerotropic or non-viscerotropic, are not enzootic in domestic poultry in the United States.

2. Velogenic non-viscerotropic Newcastle disease may be as destructive as VVND if introduced into domestic poultry.

3. The present regulations which restrict action to VVND can delay depopulation or other appropriate action when velogenic non-viscerotropic types of viruses are isolated, and this may increase the risk of spread and cause embarrassment to regulatory agencies.

Based on the above, the committee unanimously recommended that:

1. Birds or populations of birds known to harbor any Newcastle disease virus that produces lethal infection in chickens should not be imported to the USA.

2. The feasibility of classifying velogenic Newcastle disease as an exotic disease should be assessed. Assessment should include identification of possible remaining foci of velogenic NDV infection in domestic poultry, and estimation of eradication costs. If economically feasible, all velogenic NDV should be considered exotic to the USA and eradicated if detected.

3. The definition of velogenic should be the same as now used to determine that a strain is VVND except that demonstration of viscerotropic lesions would not be necessary. Consideration should be given to using ocular or respiratory challenge rather than cloacal swab. Susceptible chickens 4 weeks of age or older will be used.

4. The use of possession of velogenic strains such as GB should be limited to qualified laboratories under permit of USDA.

5. Research should be encouraged and funded to find rapid and reliable procedures for identifying chicken lethal Newcastle disease viruses currently defined as velogenic.

CERTIFIED VVND NEGATIVE FLOCKS

The subcommittee for VVND Negative Flock Certification programs did not meet during 1983. However, the full committee re-affirms its enthusiastic support of the VVND Negative Flock Certification program adopted by USAHA in 1978 for turkey primary breeding flock and in 1982 for chicken primary breeding flocks. The committee further urges the USDA-APHIS Veterinary Services to implement these programs as soon as possible.

MYCOPLASMOSIS

Testing Inconsistencies. There is strong consensus that highly accurate, consistent serologic procedures are essential for vigorous participation of industry in APHIS/NPIP programs for avian mycoplasmosis.
Accordingly, committee members, in concert with the American Association of Avian Pathologist (AAAP), have actively supported the following:

1. Implementation of a national survey concerning inconsistent results with mycoplasma antigens.
2. Preliminary plans by APHIS to check-test selected laboratories for the effectiveness of current mycoplasma testing procedures.
3. Proposals for research aimed at resolution of current difficulties in the serologic classification of breeder flocks with weak reactions to mycoplasma serum plate antigens.

**Education and Promotion.** In recognition of the practical feasibility and economic necessity of cleaning up *M. gallisepticum* (MG) infected table egg complexes, the committee is assisting AAAP in the development of detailed authoritative instructional aids for industry concerning the achievement and maintenance of MG eradication on multiple age operations. A letterhead logo developed by Dr. Michael Opitz, University of Maine is an example of the kind of innovative promotion that is needed to lead industry into greater participation in APHIS/NPIP mycoplasma eradication programs at both the breeder and production levels.

**Proposals and Recommendations to NPIP.** The advisability of the following proposals for new NPIP classifications will be investigated during the forthcoming year.

1. U.S. M. Synoviae Clean Turkeys

**1981 Resolutions.** The committee re-affirmed the 1981 Resolution urging stronger USDA support of 1) avian mycoplasma diagnostic referral services at selected laboratories located in the east, west, and midwest, and 2) field trials on M.G. eradication from multiple-age layer farms through the use of various control techniques.

**Resurgence of Classical MG.** Outbreaks of the more pathogenic, classical forms of MG infections appear to be increasing according to various field reports. Failures to make costly unpopular decisions with infected breeder flocks was identified as a significant factor in the emergence of this problem.

**MODEL STATE PROGRAM FOR PET BIRDS**

The sub-committee on the Model State Program for Pet Birds met several times during 1983 in an effort to obtain clarification of and support for the adoption and implementation of the National Cage and Aviary Bird Improvement Plan (NCABIP) as proposed by this sub-committee and the USAHA in 1982.

Several meetings were held with administrators of APHIS-USDA in Washington, D.C. in an attempt to further formalize the language of the NCABIP proposal so that it would be ready for consideration, adaption,
implementation and could be published in the Federal register at the appropriate time.

Many members of other organizations, including those in the exotic pet bird fields, the poultry industry groups, and interested veterinary organizations were contacted in order to explain the concept of our proposed program and to attempt to answer any pertinent questions they might have had concerning it.

We obtained further endorsement of our program through resolutions passed by many of these organizations and groups.

It is important to continue to explain the mechanism of the proposed program to interested parties, and must work for passage of Congressional legislation in the form of a simple amendment to the act which provides NPIP’s authority. The amendment would add “other avian species” to NPIP’s authority and permit the establishment of the NCABIP under the umbrella of the NPIP. It is possible that we may need a separate act to establish the NCABIP program. In either event, we must remain steadfast in our efforts to secure the establishment of this needed plan. It provides:

1. An opportunity to create a practical widely implemented system of traceability, and
2. The beginning of a modicum of improved, acceptable industry-developed hygienic standards for cage and aviary birds.

Dr. R.E. Baer, Chairman of the Subcommittee of Cage and Aviary Birds, has requested current inactivation of his committee in as much as a large extent of this committee’s concerns are being served by the Subcommittee on Model State Programs for Pet Birds. Members of both committees have worked very closely in recent years and are in accord with recommended actions. It was further recommended that the Cage and Aviary Bird Subcommittee be reactivated should new problems arise of particular concern to aviculturists and the cage bird industry.

OTHER TOPICS

A report was presented by Dr. Milton Friend, U.S. Wildlife Service, which emphasized that two distinctly different populations of wild waterfowl need to be recognized. One is represented by native free-living wild stock, and the other by stock that has been raised in captivity and released. These latter, captive-reared water-fowl need careful consideration in the elucidation of the epizootiology of disease transmission to both domestic poultry and wild waterfowl. A significant interface does exist between large and small poultry flocks and captive-reared waterfowl. This is further then complicated by the regular release of these captive-reared fowl into the wild in large numbers annually.

The following subcommittees were formed:

AVIAN INFLUENZA: R. A. Bankowski, C. Beard, F. Craig, D. King, D. Halvorson, J. E. Pearson, I. Peterson and B. S. Pomeroy, Chairperson
MYCOPLASMOSIS: D. Johnson, D. McMartin, E. T. Mallinson, B. S.
Pomeroy, I. Peterson, W. Towers, R. Yamamoto and H. O. Opitz, Chairperson

**POULTRY FLOCK CERTIFICATION PROGRAM:** F. Craig, H. Goldstein, R. L. Hogue, J. E. Pearson, I. Peterson, E. I. Pilchard, B. Pomeroy, P. Smith, J. Thomas, W. T. Tramel, C. Weston, and R. McCapes, Chairperson

**NEWCASTLE DISEASE REEVALUATION:** R. A. Bankowski, C. Beard, M. Cover, J. E. Pearson, S. A. Vezey, and L. Grumbles, Chairperson

**MODEL STATE PROGRAM FOR PET BIRDS:** T. Angel, R. E. Baer, H. Goldstein, S. Clubb, D. J. Ligda, E. T. Mallinson, M. Myers, R. Schar, and H. Kahan, Chairperson

**PARAMYXOVIRUS EVALUATION:** I. A. Bahl, R. A. Bankowski, C. Beard, D. King, C. Weston, and J. E. Pearson, Chairperson

### TABLE 1
**IMPORTANT QUARANTINE STATION VIRUS ISOLATIONS**

**NVSL - AMES, IOWA**

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<td>USDA facilities</td>
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<tr>
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<td>Influenza positive lots</td>
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<td>0**</td>
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<tr>
<td>Strain of influenza virus</td>
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<td>PMV2 percent of HAV isolates</td>
<td>62.7</td>
<td>57**</td>
</tr>
<tr>
<td>PMV3 percent of HAV isolates</td>
<td>37.3</td>
<td>43**</td>
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<td>VVNDV positive lots—private facilities</td>
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<td>VVNDV positive lots—USDA facilities</td>
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<td>VVNDV positive lots—confiscated birds</td>
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*Through Aug. 15, 1983

**Only 246 of the 515 hemagglutinating isolates have been typed

**Isolates were only typed as velogenic

HAV—Hemagglutinating Virus
PMV2 Paramyxovirus—2 (Type strain-chicken/California/Yucaipa
PMV3 Paramyxovirus—3 (Type strain-turkey/Wisconsin/68)
VVNDV—Velogenic viscerotropic Newcastle disease virus
VNDV—Velogenic Newcastle disease virus
The idea of a Pseudorabies Pilot Project in Illinois has been discussed since the LCI Meeting held in St. Louis in 1981. The Illinois Pseudorabies Advisory Committee requested comments from county pork producer groups and agricultural extension personnel on possible project areas in the fall of 1981. County meetings were held in the three counties expressing interest—McDonough, Macoupin and Pike—to provide and solicit further input. Due to lack of federal funding at that time, little progress was made but a Pseudorabies Pilot Project Protocol was developed.

The Protocol was revived in February, 1983, when it became known that funding from USDA and the National Pork Producers Council was now a reality. The Protocol underwent at least a dozen revisions and drafts until a plan satisfactory to most of the parties concerned was developed. When a stalemate developed with USDA over the inclusion of a moderate amount of indemnity in the Illinois project it was nearly dropped but the interest of a few individuals kept it alive. A special meeting of the Illinois Pseudorabies Committee was called on February 9, 1983. The decision was made to take the pilot project proposal, without the indemnity provision, to the producers in the individual counties for their reactions. A special Pilot Project Selection Committee was formed, consisting of the President, Executive Vice President, and a prominent member of the Executive Board of the Illinois Pork Producers Association, plus their representative to the National Pork Producers Council; a representative of the Illinois Agricultural Association; the Swine Extension Specialist and the Swine Extension Veterinarian from the University of Illinois; the Veterinary Services, USDA, Veterinarian in Charge in Illinois; the Superintendent of the Division of Meat, Poultry and Livestock Inspection, and Chief Veterinarian, Bureau of Animal Health of the Illinois Department of Agriculture. The selection committee, plus Dr. L. W. Schnurrenberger from the Special Diseases Staff, Veterinary Services, USDA, Hyattsville, Maryland, met with pork producers and extension personnel in a series of three meetings in the counties on April 19, 1983.

The phases of the pilot project were outlined as follows:

1. Designate a project area of one or slightly more than one township, the area to be subject to expansion if favorable progress was made in the initial township and if funds were available.
2. Survey the swine population in the designated area.
3. Determine the pseudorabies status of all herds in the area.
4. Develop individual herd plans for each infected herd with the objective of eliminating pseudorabies infection.
5. See if the area, once clean, can be maintained free of pseudorabies through monitoring testing.

6. Evaluate the Gustafson capsular antigen intradermal test (skin test) as a diagnostic test under field conditions.

The optimum specifications for the project township were outlined as follows:

1. Swine population that is representative of the entire county.

2. Have known present or previously pseudorabies infected herds in the township.

3. Have somewhat natural boundaries as far as the swine population is concerned.

4. Have cooperation of the pork producers within the township.

The groups in Macoupin and Pike Counties expressed enthusiastic support if selected as the project area. The McDonough County group expressed a desire to be withdrawn from consideration. The Selection Committee, after considerable deliberation, reached the decision to split the Illinois project into two sections—one in Macoupin County and one in Pike county. The individual areas were then established as follows:

A. Detroit Township, on the eastern side of Pike County, which is in western Illinois, in the top three counties in the state in swine numbers, and with the second highest number of confirmed cases of pseudorabies in the state during the 1976–83 recording period. Detroit Township is rolling to rough in terrain, bordered on the east by the Illinois river and on the west by farming area with few swine units. Swine production units range from confinement to open rearing. There are three purebred breeders in the area and several commercial gilt producers, in addition to farrow-to-finish operations and two or three strictly feeder operations. There were four qualified pseudorabies negative herds in the township, two of which had experienced heavy pseudorabies infection in preceding years. The owners had decided that they could not live with the disease and had voluntarily cleaned up their herds. A summary of progress is shown in Figure 1.

B. South Palmyra and the west one-half of South Otter townships in north-central Macoupin County, which is in west-central Illinois. (Pike and Macoupin counties are about 50 miles apart.). Macoupin County is in the top ten counties in the state in swine numbers and had the third highest number of confirmed cases of pseudorabies in the state during the 1976–83 recording period. The project area is level to rolling in terrain and has many intensified grain and livestock operations. State highways provide some well-defined boundaries. The 1½-township area selected had two herds under pseudorabies quarantine at the time the project started. There were no qualified herds in the area. Herd size ranged from one sow to 750 sows. There were five strictly feeder pig finishers, with the remainder
being farrow-to-finish operations. A summary of progress is shown in Figure 2.

Listings of all parties believed to have swine in the area had been prepared in advance by extension personnel and producer groups. Two Division personnel surveyed each producer individually to obtain specific information. Survey form is shown as Figure 3.

Herd plans were developed for all positive herds by Dr. Richard White, Swine Diseases Specialist, Veterinary Services. The LCI booklet, “Swine Pseudorabies Eradication Guidelines,” was given to each infected herd owner and herd plans were patterned generally on Plans A, B or C. Another LCI booklet, “Epidemiology of Pseudorabies Virus, Current Knowledge,” was widely used in herd owner contacts and during survey activity.

While it is still early to form definite conclusions on the project, the following items have become apparent:

1. More positive herds were encountered than had been anticipated—15 out 61 tested, or 24%. Eleven of the 15 positive herds had less than 60 head of breeding swine per herd.

2. Five herds had single SN positives. Additional testing without more positives, epidemiology and subsequent negative ELISA test on three of the samples at NVSL lead us to believe that we were dealing with nonspecific titers, although they ranged from 1:8 to 1:256. We plan to do more work with this type of animal, if more occur.

3. We have had moderate success in removing SN positive animals, retesting at 30-day intervals, and qualifying herds for release from quarantine, after two negative tests. We had very little success with this procedure in Illinois when used previously.

4. The skin test is not working as well as a herd diagnostic test as we had hoped. With few exceptions, all animals receiving the skin test were also blood tested for comparative results. Correlation ranged from excellent to zero. The best results were obtained on sows and boars, with the level of correlation decreasing as gilts or feeders were involved. Attempts are now being made to improve the skin test antigen.

5. We received excellent producer cooperation for the most part. Participation in the project is entirely voluntary on the part of the producer. Three individuals in Detroit Township and three in South Palmyra-South Otter townships have not indicated willingness to participate to date; in addition, there are five feeder pig finishers that have not been screen tested up to this time. The extremely hot and humid weather encountered in Central Illinois this year limited testing to early morning hours but both producers and testing personnel readily accepted this.

6. If a very moderate amount of indemnity had been available, we feel that four or five of the owners of small, positive breeding herds would
have depopulated immediately, thereby removing a focus of infection. Two did subsequently depopulate voluntarily and we anticipate that two more will do so this winter.

Current plans in Illinois call for expansion into two townships south of Detroit Township, Pike County, in mid-October, and probable expansion of the Macoupin County area at a slightly later date.

**FIGURE 1**

**ILLINOIS PSEUDORABIES PILOT PROJECT**

**DETOUR TOWNSHIPS—PIKE COUNTY**

Approximately 33 square miles — 39 swine producers

Township meeting, April 25, 1983 – Survey, week of April 25, 1983

Testing started, week of May 3, 1983.

Results through 9-30-83, including buffer area:

**SN Test**—Used in 36 herds

36 initial herd tests

27 herds negative – 9 herds with 1 or more positives

(2 were in buffer zone, 4 had a single titered animal only)

16 retests conducted in positive herds

7 maintenance tests conducted in negative herds—

1 positive animal on a maintenance test

1,326 head of swine tested

1,257 negative — 69 positive, principally in 2 herds

**Skin Test**—Used in 16 herds

224 negative — 15 herds all negative

6 positive — all in 1 herd

Disposition of Positive Herds:

3 released through retesting

2 sold all swine

4 still under quarantine

3 herds did not participate in the project.
FIGURE 2
ILLINOIS PSEUDORABIES PILOT PROJECT
South Palmyra and west 1/2 of South Otter Townships
Macoupin County

Approximately 50 square miles — 38 swine producers

Township meeting, May 16, 1983
Township survey, week of May 23, 1983
Testing started, week of June 6, 1983

Results through 9-30-83:

**SN Test**—Used in 25 herds
  - 25 initial herd tests
  - 19 herds negative
  - 6 herds positive
  - 3 retests conducted in positive herds

- 497 head of swine tested
- 402 negative
- 95 positive

**Skin Test**—Used in 25 herds

- 452 negative — 21 herds all negative
- 95 positive in 4 herds
FIGURE 3
PSEUDORABIES PILOT PROJECT SURVEY

Farm Name, if any________________________________________ Telephone________________________

Name of Owner________________________________ Last First Initial

Address________________________________________________ Rt. # Box # City Zip Code

Directions to Farm (Include Township, Section & Farm No. If swine on more than one location, list all)

_____________________________________________________________________________________

Best time to contact__________________________________________ Code:______________________

Practicing Veterinarian, if any______________________________ Code:______________________

Type of Operation: (Check one or more as applicable)

☐ Seedstock Producer ☐ Purebred ☐ Grade ☐ Both
☐ Farrow-to-Finish
☐ Feeder Pig Finisher
☐ Sells Feeder Pigs ☐ Other

Facilities:

☐ Total Confinement ☐ Partial Confinement Open Front Buildings ☐ Pasture

Type of airflow, if confinement

Testing Facilities Available

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________
Preferred Time for Testing: Day of week__________________________ Time__________________________

Owner Assistance Available____________________________________________________________

Normal Feeder or Slaughter

Marketing Patterns:

☐ Auction Market__________________________ ☐ Stockyards__________________________

☐ Buying Station__________________________ ☐ Direct to Slaughter Plant__________________________

☐ Private Treaty__________________________ ☐ Other__________________________

Number of Swine on Farm

_______ Breeding (5 months of age and over) _____________ Breeding (under 5 months of age)

__________________________ Finishing (Feeder) Swine

Qualified PRV Negative Herd: ☐ Yes ☐ No

Is owner interested in obtaining a qualified negative herd ☐ Yes ☐ No

Date__________________________

Signature of Surveyor__________________________

Skin Test Results: Date________ Negative________ Positive________

Serum Neutralization Test Results: Date________ Negative________ Positive________

☐ Check here if there is additional information on reverse side.
On April 5, 1983, at a meeting in Marshalltown, Iowa, with some 100 + pork producers in attendance, Marshall County was officially designated as the preferred area to conduct a PRV Pilot Project to attempt to control pseudorabies. It was announced at that meeting that for the area to be acceptable, 75 percent of the pork producers representing 90 percent of the swine must be willing to participate in the project.

Marshall County pork producers under the leadership of Lee Garrett and Doug Harper accepted the challenge and on June 20, 1983, Governor Terry Branstad, at his weekly press conference made the official announcement that Marshall County had met the challenge with approximately 98 percent of the pork producers in the area willing to participate.

On July 5, 1983, ninety days following the initial announcement, the project officially got under way. Local practicing veterinarians were briefed on the testing procedure to follow under Phase I of the program as follows:

Initial testing to determine herd PRV status was to commence immediately in Iowa, Taylor and Marietta Townships. Testing in other areas of Marshall County will follow in an orderly manner.

Initial test of all cooperating herds, vaccinated or not, shall include:

- 25 percent of all adult breeding males
- 100 percent of all adult breeding females
- 10 percent of all other age groups (except nursing pigs)

All lots and units to be proportionately represented in the sampling regardless of their vaccination status.

Subsequent testing, number and frequency, will be determined by the individual herd plan.

A project director has been employed under a State–Federal cooperative agreement to supervise and coordinate the project. That person is Dr. Roy Gallentine, Gilman, Iowa, a recently retired veterinarian, a life-time resident of Marshall County and an SPF swine producer in his own right. We feel fortunate in being able to obtain the services of Dr. Gallentine as the on-site project director.

Initial testing of herds involved in the pilot project in Marshall County got under way during the month of July in spite of the adverse weather conditions. During the first three weeks, 25 herds were tested with the following results:

20 Herds Found Negative:
- 12 Non-Vaccinating Herds, All Tested Animals–Negative
- 8 Adult Vaccinated Herds, All Progeny Tested–Negative
- 1 Herd Recent Clinical Symptoms–Virus Isolated–Positive
1 Herd Feeder Pig Finishers—Tested Positive
3 Herds Where Initial Test Was Inconclusive—Status Unde-

termined

25 Total Herds

Our project in Marshall County is turning out to be of a larger dimension than originally estimated. We already have signatures of over 230 swine producers in the county wanting to participate. Our original estimate of approximately 140 swine producers in the county was based on USDA statistics for 1981.

Weather continued to be very adverse through Labor Day which prevented us from reaching our intended goal of having completed the initial test on all cooperating herds in the project area by the end of September. Thirty-two more herds were testing in August and an additional 43 in September.

A revised testing schedule as recommended by the Technical Advisory Committee was adopted in late August and is currently being utilized to determine initial herd status.

REVISED TESTING SCHEDULE—AUGUST 22, 1983

1. Unvaccinated Breeding Herds:
   a. Herd of less than 100 adult breeding animals, test all animals up to 25 head.
   b. Herd of 100 to 200 adult breeding animals, test 27.
   c. Herd of over 200 adult breeding animals, test 28.

Tested swine are to be selected at random and include all recent additions, all herd boars and all groups to be proportionately represented.

2. Vaccinated Breeding Herds:
   a. Same schedule as above to screen for titer levels in adult breeding herd.
   b. Also, using the same testing schedule test progeny (4 months +). All lots and groups to be proportionately represented.

If the herd owner is desirous of establishing a Qualified PRV-Negative Herd or PRV Controlled Vaccinated Herd, the animals in the herd necessary to meet the qualifications will be tested.

Swine movement within the area and the testing schedule for feeder pig finishers remains unchanged.

The initial test was completed on 100 herds by September 29, 1983, with the following results:

<table>
<thead>
<tr>
<th>Herds Tested</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>Clean</td>
<td>22</td>
<td>29</td>
<td>36</td>
<td>87</td>
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<tr>
<td>Infected</td>
<td>2</td>
<td>3</td>
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<tr>
<td>Undetermined</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>3</td>
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</table>

Probable Status:
Vaccinated Herds 8 7 13 28
TOTAL TESTED 696 1006 1615 3317

Comments and Observations:
1. Sixteen producer herds practice adult vaccination and are considered probably “clean” status.
   11 herds all progeny tested negative.
   5 herds contained progeny with titer no higher than 1:4.
   Adult breeding animals in the herds carried titers of 1:16 or less.
2. Fifteen producers that purchase and finish feeder pigs have been tested. Fourteen are considered clean and only one has been found infected.
3. Eleven new herds have met Qualified-Free Status.
4. Four herds that were known to have been infected four or more years ago and have been on a regular adult vaccination program are now apparently free of pseudorabies.
5. Two herds that were infected 3–4 years ago were able to clean up by following a vaccination testing and progeny isolation program.
## PSEUDORABIES PROGRESS REPORT

<table>
<thead>
<tr>
<th>TOTAL TESTED</th>
<th>BREEDING</th>
<th>PROGENY</th>
<th>VACC USED</th>
<th>PROBABLE STATUS</th>
<th>REMARKS</th>
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</tr>
</tbody>
</table>

**REMARKS**
- Feeder Pigs Only
- Entire Herd
- Feeder Pigs Only (60)
- Feeder Pigs Only (25)
- May Depopulate
The Swine Health Committee of the South Dakota Pork Council met in Madison on July 28th, and after considerable discussion voted unanimously to make a request for money from the Livestock Disease Emergency (L.D.E.) fund to initiate and conduct a testing and clean up program of those herds that are presently under quarantine in South Dakota with the disease of Pseudorabies.

The disease of Pseudorabies has been present in our State and has been quarantinable since early in 1977. Some of these herds still under quarantine have continued to produce market hogs, and although some have been on a vaccination program, this does not eliminate the virus or prevent its spread. Swine act as a natural host of this herpes virus, that causes Pseudorabies, and thus may act as a carrier without showing any clinical symptoms, but yet under certain conditions or times of stress, will shed the virus and thus infect any susceptible swine that may come in contact with the virus.

In South Dakota there are still 22 herds under quarantine for the years of 1977, 1978, and 1979. In addition to this there is another 22 herds under quarantine for the years of 1980, 1981, and 1982. This is alarming but even more so is the fact that already in 1983 32 herds have been placed under quarantine. (This includes 15 farms that are members of 2 Coops—that have become infected with considerable losses.)

In South Dakota there are still 22 herds under quarantine for the years of 1977, 1978, and 1979. In addition to this there is another 22 herds under quarantine for the years of 1980, 1981, and 1982. This is alarming but even more so is the fact that already in 1983 32 herds have been placed under quarantine. (This includes 15 farms that are members of 2 Coops—that have become infected with considerable losses.)

The swine industry of South Dakota is one of the major livestock segments of our State, with the total value running into several millions of dollars. When this industry is threatened or endangered by a disease such as Pseudorabies, and especially since we do have the ability and technology to at least reduce these foci of potential infection, we feel that it is very justifiable to make a request from the L.D.E. fund to pay for such costs of testing infected herds only.

Local practitioners would be used to draw the blood samples, at a cost of approximately $2.00 per head. Laboratory cost to conduct the serum neutralization would be another $2.00. This plus a small amount for testing equipment and supplies, would make the cost factor of the proposed program.

In South Dakota at the present time, there are some 60 herds under quarantine for the disease of Pseudorabies. However, with the several options and plans to be considered, it is very difficult to arrive at an exact cost figure for the program. Also herd sizes vary considerably and in some several repeat tests are going to be required, thus making the total costs vary somewhat. Best estimate is that if $48,000.00 were earmarked for testing of infected herds only, that this would make considerable headway in the reduction of the infection and source of the Pseudorabies Virus.

Any funds that are not needed or used in the conducting of this proposed program, would be returned to the L.D.E. fund.
The governor of South Dakota has released the above amount for said purpose.
RADIAL IMMUNODIFFUSION ENZYME ASSAY (RIDEA) FOR DETECTION AND QUANTITATION OF ANTIBODIES TO PSEUDORABIES VIRUS IN SWINE

by Han Soo Joo, Al Leman, Tom Molitor
College of Veterinary Medicine
University of Minnesota

Pseudorabies antibody can be simply tested overnight using a radial immunodiffusion enzyme assay (RIDEA) kit. The antibody titers are visualized in a colored circular zone and diameters of each zone can be converted to serum neutralization titers of the official test.

A. Principle of Test
Noninfectious pseudorabies virus antigen is bound to the surface of the plate and overlayed with agar. Following the test serums are added to the wells, antibodies are radially diffused through the agar, and specific antibody binding to the antigen occurs. After the antigen antibody reaction is left for an overnight period and the agar is peeled off, the washing step removes unbound (non-specific) antibodies. Species specific enzyme—linked anti-immunoglobulin (conjugate) is then added. This will bind with attached antibodies. The washing process removes any unbound conjugate. Addition of agar with substrate and H$_2$O$_2$ (catalyst) result in a reaction between the enzyme in the conjugate and the substrate, producing a colored ring (Fig. 1). The diameter of the ring produced can be related to the amount of specific antibody present in the serum (Fig. 2).

B. Kit Contents (for testing 28 serum samples)
1. 4 antigen coated agar plates
2. 20 mls concentrated washing solution
3. 20 mls agar
4. 1 vial substrate
5. 1 vial H$_2$O$_2$
6. 1 vial conjugate (frozen)
7. 1 vial positive control serum
8. 1 vial negative control serum

C. Equipment and Reagents Needed to Perform Test
1. Sterile distilled water
2. 200 ml bottle and 20 ml bottle (or tube)
3. Two 5 ml and one 10 ml syringes
4. Vessels to boil water
5. A ruler (mm)

D. Reagent Preparation
1. Washing solution (IX 200 mls)
   —in 200 ml bottle: 20 mls conc. washington solution
   180 mls distilled water
   200 mls washing solution

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2. Agar preparation
—It is best to melt agar in boiling water while plates are incubating with conjugate solution. After agar is melted it can be placed in a 45–60°C waterbath until it is ready for use. Immediately before adding agar to the plates, add the substrate and H₂O₂ and agitate until completely dissolved.

E. Procedure
1. To separate wells of one of the plates, add 15μl each of the positive and negative control serum. Add 15μl of serum to be tested to each of the remaining wells. (note: use capillary tubes to add 15μl [0.015 mls] to each well. If 15μl can not be measured, fill wells to the top, trying not to overflow.)
2. Let plates incubate with cover at room temperature (on the bench top) overnight (~15–18 hours).
3. Prepare 1X wash solution, and conjugate solution (mix 1 vial conjugate into 12 ml 1X wash solution).
4. Remove agar from plates (hold plate on edge and use a capillary tube to lift edge of agar and it will peel off).
5. Wash each plate 3 times with 5–8 mls of washing solution (use 10 ml syringe, add washing solution slowly from the edge of the plate and pour off, no agitation is needed while plates are being washed).
6. Add 3 mls of prepared conjugate solution to each plate an incubate 45–60 minutes at room temperature (while plates are incubating with conjugate, place tube of agar in boiling water until it is completely melted, then keep agar in 45–60°C until ready to use).
7. SLOWLY pour off conjugate solution and wash each plate 3 times with 5–8 mls of washing solution (use syringe, add SLOWLY from edge of plate and pour off immediately).
8. Take agar (45–60°C) and add substrate and H₂O₂ and mix. Immediately add 5 mls of prepared agar to each plate (add agar slowly from edge of plate).
9. Let plates cool without disturbing and interpret results when rings are dark enough to measure (approximately 10 minutes).

F. Interpretation of Results

<table>
<thead>
<tr>
<th>Ring Diameter (mm)</th>
<th>Approximate Ranges of Neutralization Titer</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 6.5</td>
<td>Negative [&lt; 1:2]</td>
</tr>
<tr>
<td>7.0 – 8.0</td>
<td>1:2 – 4</td>
</tr>
<tr>
<td>8.0 – 9.0</td>
<td>1:4 – 8</td>
</tr>
<tr>
<td>9.0 – 10.0</td>
<td>1:8 – 16</td>
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<td>1:16 – 32</td>
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<tr>
<td>&gt; 11.0</td>
<td>&gt; 1:32</td>
</tr>
</tbody>
</table>
Figure 1. Colored zones produced in a RIDEA test by 4-fold dilutions of a PRV positive swine serum (VN titer 64). From center to top and anticlockwise 4-fold dilutions (1:1-4096).

Figure 2. Relationship between the diameters of RIDEA test and VN antibody titers to PRV.
AUJESZEKY'S DISEASE (PSEUDORABIES) IN GREAT BRITAIN—THE CONTROL AND ERADICATION SCHEME

R. H. Goodhand, D.V.M.

THE HISTORY OF THE DISEASE IN GREAT BRITAIN

In GB, Aujeszky's Disease was first recognized in Somerset in 1953, although it had been reported from Northern Ireland in 1939 where it still causes problems. These early reports were of isolated short-lived outbreaks, causing few clinical signs in pigs and often identified only by classical signs in cattle which were in contact with pigs, or by sudden deaths in hounds fed on infected pig carcases.

During the early 1970s outbreaks of severe clinical disease started to be seen in England. The number of infected premises identified began to increase and by 1977, infection appeared to be concentrated in 3 main areas: Yorkshire, Humberside and the Rishangles area of East Anglia—all have large pig populations kept in intensive units. During the period 1977–80, infection appeared to spread principally in these areas but, in the early 80s, new foci of infection began to appear in North Humberside, North Yorkshire and Lancashire.

The introduction of infection into a herd may not of course immediately result in an outbreak of disease and some outbreaks are mild or indistinguishable from other nervous diseases such as streptococcal meningitis. This hampers the tracing of infection but it is considered that the spread of AD in Great Britain has been mainly due to 2 processes:

(a) The movement of infected pigs—principally weaners.
(b) Local spread from an infected pig unit.

Infected units may give rise to a cluster of outbreaks in surrounding pig herds, particularly in areas where herds are numerous. The method of local spread is obscure; there is a suggestion that it may be due to aerosol produced by forced ventilation systems or, alternatively, that rats or foxes may be transmitting infection either as vectors or as mechanical carriers.

The origins of 169 outbreaks recorded up to December 1981 were attributed to:

<table>
<thead>
<tr>
<th>Local spread</th>
<th>Movement of pigs</th>
<th>Contaminated vehicles or personnel</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>23</td>
<td>15</td>
<td>83</td>
</tr>
</tbody>
</table>

Up to 1979, when the disease was made notifiable by law, the number of outbreaks per year remained low, being always less than 15, and the British State Veterinary Service was involved in recording outbreaks and advising farmers and private veterinary surgeons on control measures which could be adopted on individual farms. In 1980, the farming industry requested that a poll of pig producers be undertaken to find out if there was sufficient support for an industry financed eradication scheme. The results of this poll failed to show the necessary level of support.
Following further discussions between the Government and interested parties, legislation was introduced in May 1982 which gave the State Veterinary Service additional powers in the struggle to control the disease, by means of the imposition of movement controls in herds in which clinical disease had been confirmed.

In 1982 there was a very sharp rise in the number of newly infected premises identified and, as a result, there was renewed pressure for some kind of Government action and the various options available for an industry funded control and eradication policy were studied and carefully evaluated. The final conclusion was that a policy of slaughter with compensation for all pigs in an infected herd, with salvage of the clinically healthy pigs for human consumption, would be the most appropriate. Vaccination was considered to be too expensive and, although it would tend to lower the economic losses due to the disease, it would not adequately control spread of infection. Also the use of vaccine would present serious complications if eradication on the basis of serology was ever entered into the future.

Against this background another poll of pig farmers took place in November 1982 and on this occasion there was overwhelming support for an industry-financed slaughter and compensation policy with the owners of 75% of the total national pig herd voting in favour. As a result of this the present control and eradication policy was introduced and commenced on the 14 March 1983.

THE CURRENT CONTROL AND ERADICATION PROGRAMME

The present control and eradication scheme entails the slaughtering out of all herds in which the disease is confirmed. That is, herds where clinical disease exists and also those where, although no clinical disease is present, blood tests reveal evidence of infection. The financial arrangements involve a compulsory levy on the pig industry of 30p (45 cents) on all pigs consigned for slaughter or export. The levy, which is not payable on pigs compulsorily slaughtered under the Scheme, is collected by the Meat and Livestock Commission and handed over to the producer's Company (Pig Disease Eradication Fund) which administers the finances. Compensation to owners of pigs slaughtered under the Scheme is met initially by the Ministry of Agriculture but the cost is recouped from the Pig Disease Eradication Fund. In addition, salvage receipts for healthy pigs salvaged for human consumption are returned via Ministry to the Pig Disease Eradication Fund.

The levy fund is used:

(a) To compensate owners at current market value up to a maximum payment of £300 ($450) for any one pig slaughtered, and
(b) To compensate owners for the costs of disruption when their unit is empty until the time it is returned to production. This is on the basis of an additional 20% of the compensation value for breeding herds and 5% for fattening herds.
These compensation payments were formulated by the industry, since it is the pig producers who are funding the eradication programme. However, veterinary and associated costs are met from government funds.

Enabling legislation was introduced giving the State Veterinary service powers to:

1. Require notification of suspicion of disease.
2. Serve restrictions on the movement of pigs.
3. Investigate suspicion or report of disease.
5. Trace for spread or origin of infection.
6. Value pigs and pay compensation.
7. Slaughter pigs.
8. Require cleansing and disinfection of infected premises.

Brief details about the various activities listed above are as follows:

1. **Notification**

   Although slaughter and compensation is implemented only in respect of swine, suspicion of the disease must be notified in cattle, sheep, goats, swine, deer, horses, dogs and cats. Such a provision is necessary as it can lead to the identification of disease in pigs when the first manifestation of clinical signs is in another species.

2. **Restrictions**

   These are served on suspect premises during the investigation process and the farmer is legally bound to impose restrictions on his pigs himself immediately disease is suspected on his premises.

3. **Investigation**

   This involves:
   
   (a) Clinical inspection.
   (b) Post mortem examination and collection of tissues for virus isolation and/or histopathology as appropriate.
   (c) Collection of blood samples for serological examination by ELISA tests and occasionally by SNT in addition.

4. **Confirmation**

   Confirmation is based on:
   
   (a) Clinical signs.
   (b) Results of laboratory testing.

   For blood samplings purposes the sample size is statistically designed to detect one sero-positive pig in any herd with a 5% prevalence of infection, at the 95% level of confidence.

5. **Tracing**

   Following confirmation of disease, tracing of other pig herds takes place to detect the origin of infection of herds subsequently infected as a result of spread. Under this heading it should be noted that 10 days following depopulation of infected premises, all pig herds within
2 km of the premises are inspected and subjected to a blood test. This is known as the 2 km patrol.

6. Value and Slaughter

The Ministry of Agriculture appoints a local valuer, usually with the agreement of the farmer, to value the pigs at current market value disregarding any depreciation due to AD. Following valuation the premises are depopulated. Pigs which are marketable and clinically healthy are sent for slaughter for human consumption and those which are diseased or otherwise unmarketable are slaughtered and disposed of by burial, burning or heat processing for purposes other than human consumption.

7. Cleansing and Disinfection

This is the responsibility of the farmer with technical advice from the State Veterinary Service. It is carried out at the farmer's expense. The Phasing Programme. Normally it is an animal health imperative to kill infected animals with the greatest possible speed. In the case of our control and eradication programme, it is also important to be seen to be dealing with the disease as expeditiously as possible in order to satisfy producers, whose money is being expended, that delay is not costing them more. On the other hand, regard has to be given to two other factors. The FIRST is the constraints on veterinary and administrative resources and the SECOND is that commodity considerations have to be taken into account to a greater extent than usual. It was clear that salvage values of unaffected pigs from infected herds would be a critical factor in reducing the net cost of the compensation payable; also it would be important to avoid unloading on to a limited market pigs in such quantities that prices would fall to an undue extent.

Because of these constraints it was decided that the programme would be divided into three distinct phases, aimed at dealing first with those herds posing the greater potential for spread of virus. These phases were planned as follows:

PHASE 1

To deal with herds in which the disease has been diagnosed since 4 May 1982 and, within that time scale, priority to be given to herds with current clinical disease.

PHASE 2

To deal with herds in which the disease had been diagnosed during the period 1 August 1979 to 3 May 1982.

PHASE 3

To deal with herds in which the disease had been diagnosed prior to 1 August 1979.

Within each Phase certain other priorities had to be considered, such as herd type and location. Since herds selling weaner pigs, for example,
present a greater risk of spread than those selling only fat pigs, they establish a different priority within a phase and are dealt with first. As regards herd location, priority within a phase is given to herds in an area of high pig population.

It was also considered necessary to deal with previously infected premises which had for a variety of reasons been depopulated of pigs. Our concern was that, although the infected premises were now depopulated, disease might have been spread at some previous time to neighboring herds. Accordingly an investigation by patrol of all pig herds within 2 km of these was undertaken.

The programme commenced on 14 March 1983 and the overall period for dealing with herds in Phases 1, 2 and 3, and all associated tracings and patrols, was estimated to be approximately 26 weeks. This time scale has proved to be extremely accurate. All the herds in these phases have already been investigated and the patrols and tracings associated with them completed. During the course of the control campaign so far, disease has been confirmed on 412 premises involving 340,000 pigs, well over 70% of which were salvaged for human consumption. Over 3,000 veterinary visits were made to farms and the Ministry laboratories have tested over 90,000 blood samples.

For every known infected herd investigated during the 3 phases we discovered approximately 2 others as a result of tracings and patrols.

LABORATORY TESTING

The enzyme-linked immunosorbent assay (ELISA) test has been found to be the most suitable for the routine confirmation of diagnosis on the grounds of sensitivity, speed and cost.

All official testing is carried out at the Ministry of Agriculture's Central Veterinary Laboratory, Weybridge, but practising veterinary surgeons may submit blood samples for private testing to certain Government veterinary investigation centres or a private laboratory. All samples collected for private testing must be submitted with full details of the name and address of the owner of the herd, location of premises, type of herd and number of pigs in the herd and number of pigs tested. These details have to be copied to the local Divisional Veterinary Officer of the State Veterinary Service, and it is a legal requirement that any positive serum test results for AD must be disclosed by the laboratory involved to the Divisional Veterinary Officer.

FUTURE ACTION

The next stage in the campaign might well be more difficult than the initial phased control programme. It is reasonable to assume there may well be foci of infection as yet undisclosed and it will not be easy to locate them. At present consideration is being given to a number of alternative methods of findings any undisclosed disease. These include reassessment of the tracing and patrol activities engendered by the phasing programmes; National Slaughter Home Serum Surveys and publicity and awareness campaigns.
COMMITTEE ON PSEUDORABIES

Chairman: Lowell W. Hinchman
Vice Chairman: P. E. Bradshaw


The Committee on Pseudorabies met in Room 12 at the Sahara Las Vegas Hotel on October 18, 1983 with 12 members and 60 guests present.

Dr. L. W. Hinchman reported on the discovering of positive swine present exhibited during the Indiana State Fair. All subsequent testing of swine exposed at the fair has indicated that there was no lateral spread of the disease from this contact. Infected swine sold in the production sale from the '78 qualified herd were highly infected. However no infection was spread to herds in other states due to proper isolation and retesting protocol.

Dr. Paul Spencer presented a report on Illinois Pilot Project. Illinois has discussed pilot project development since the L.C.I. meeting in St. Louis in 1981. The Illinois Pseudorabies Advisory Committee requested comments as to possible project areas. However, due to lack of funds little progress was made until February 1983 when funding from the USDA and NPPC became a reality.

Phases of the project were outlined with two areas selected for the project; one each in Macoupin and Pike County.

While it is still early to form definite conclusions on the project, certain items have become apparent:
1. More positive herds were encountered than expected.
2. Five herds had single positives.
3. Had some success in removing SN positive animals.
4. The skin test is not working as well as a herd diagnostic test as hoped.
5. Excellent producer cooperation.

See Exhibit 1.

Dr. M. H. Lang reported on the Iowa Pilot Project. On July 5, 1983 the project officially got under way in Marshal County. The initial test of all cooperating herds vaccinated or not vaccinated, included 25% of all adult breeding females, 100% of all adult breeding males, 10% of all other age groups. A revised testing schedule was implemented on August 22, 1983 to enhance the former protocol and make the study more cost effective.

The initial test was completed on 100 herds September 29 with 87 tested clean, 10 infected, 3 undetermined and 28 vaccinated. See Exhibit 2.

Dr. L. W. Schnurrenberger presented the following information on various aspects of the status of pseudorabies at the present time. The Elisa test has been approved as an official test for pseudorabies.
The final rulemaking on the proposed amendment to the pseudorabies regulation, 9 CFR Part 85, is in draft form and will be published in the near future. Pseudorabies pilot projects in Illinois and Iowa have been initiated in FY 1983 with minimal support given to activity in North Carolina, Pennsylvania and Wisconsin. Pilot projects in the three latter states have been approved and the necessary agreements of protocol are being finalized. Funds for the five pilot projects are provided for in the budget proposals of the Senate and the House, however, the amount to be made available is uncertain. The Pennsylvania and Wisconsin projects are statewide with infected herds being identified by testing slaughter swine and mandatory herd cleanup is proposed. The North Carolina project will combine the statewide approach with a concentrated effort in Greene County.

Ohio has initiated an eradication program which will be supported by Federal personnel.

The 12 month pseudorabies slaughter serum survey was initiated on March 1, 1983. A total of 13,500 swine sera are to be tested to determine the nationwide prevalence. After testing for pseudorabies, the sera are being returned to the Food Safety and Inspection Service to be tested for trichinosis. A total of 5831 samples had been tested as of August 31, of which 704 (12.1%) were positive.

Don Hoogestraat presented a position paper of the South Dakota Pork Council which is included in the proceedings. See Exhibit 3.

A discussion followed on the Elisa test and the need for more work on qualitative measurement is needed.

Dr. Han Soo Joo, while presenting the protocol of a Radial Immunodiffusion Enzyme Assay test for pseudorabies also discussed the present evaluation of pseudorabies vaccine, stating that

1. It is effective in reducing clinical signs of the disease.
2. It is ineffective to prevent natural infection.
3. It is ineffective for reactivation or shedding.
4. No test for differentiating the antibody of vaccination from natural infection.
5. A possible latrogenic loss in other animals.
6. He felt that those interested in eradication should stop using vaccine.

The RIDEA test is one where antibody titres are visualized in a colored circular zone and the diameter of each zone can be converted to the serum neutralization titer. The possible uses of this test are

1. An aid for official test
2. Herd eradication surveillance to allow testing and removal.

See Exhibit 4.

Dr. Don Gustafson reported on the skin test antigen indicated that the antigenic mass used in Illinois would be increased in the future. In controlled trials the nucleocapsid antigen did not result in the production of PRV antibodies.
Dr. R. H. Goodhand presented the control and eradication program in Great Britain. The objective is total eradication.

During the early 1970s outbreaks of severe clinical disease started to be seen in England. In 1980 the farming industry requested that a poll of pig producers be undertaken to find out if there was support for industry financing. The poll failed, but carried in 1983 after a sharp rise in newly infected premises and after state veterinary service were given additional powers. See Exhibit 5.

Most of the discussion centered around the utilization of the RIDEA test at this time and Dr. John Kluge questioned as to procedures of controlling the use of all the different tests being developed to be used in the field. Those in attendance did not seem to have any answer to the question.

Dr. Lang moved and Mr. Willard Waldo second the motion that we recommend the utilization of the RIDEA test as an ancillary test in pilot projects conducted under state and federal supervision for evaluation. Motion carried.

Meeting adjourned 5:15.
POLLUTION OF DRINKING WATER AND LIVESTOCK POISONING
Robert H. Singer, D.V.M., M.S., ABVT
Winchester, Kentucky 40391

Pollution of waters that may enter into our municipal drinking water supplies has received considerable attention during the past ten years. Most of the attention has focused upon industrial chemical spills and the indiscriminate disposal of hazardous chemicals and waste materials. However, in comparison, little attention has been given to the pollution of waters utilized as drinking water for farm animals, and in many cases, rural water supplies for man as well.

Fifty years ago, the main concern of pollution of rural waters utilized for drinking purposes was diseases resulting from either human or animal fecal contamination of wells and springs. Chemical pollution of rural drinking waters for man and animals was of little importance and only appeared to occur accidently on a single premise through extreme carelessness, such as the contamination of ponds with fertilizer containing high concentrations of nitrates. During the late 1930’s and the 1940’s high concentrations of nitrates in rural well waters used as drinking water for both man and animals were recognized as the cause of poisoning in man as well as animals. In that case, the wells were generally shallow and situated near the barn lot in which the nitrates resulting from manure and its decomposition had seeped into the groundwater supplying the wells. During this period, lead was also found to be a contaminant of drinking waters on farms which were using lead pipes to convey the water to the farm animals’ water troughs resulting in chronic lead poisoning in horses and cattle.

During the past 20 to 30 years there have been many changes occurring in our rural farm communities that have greatly increased the potential hazards of chemical contamination of waters utilized as drinking water for livestock. Some of the major changes that influence the chemical contamination of waters that are utilized as drinking water for livestock include the urbanization of rural communities, improperly located municipal garbage dumps, the great expansion of various industries to small towns and rural communities, the farm use of the many chemicals classified as agricultural chemicals, and the great increase in the gasoline powered motor vehicles traveling our rural highways as well as for farm use. Let us now examine each of these influences as they provide chemical contamination of drinking water for livestock.

The urbanization of rural communities may not appear to be a great source of chemical contamination of livestock drinking water; however, the great movement of our non-farming populace to rural residences has created problems that contribute to the chemical pollution of waters utilized by farmers in the community as drinking water for their farm animals. The majority of rural residences must provide their own sewage
disposal system in the way of a septic tank. They have a problem of disposing of garbage and disposing of trash and other waste products also.

It is found that many of the rural septic tank systems are only adequate for one family dwellings and not intended for excessive household water drainage such as occurs with automatic clothes washers. Consequently, there is a constant overflow of the septic tanks of raw sewage fluids into the ground which may find its way into ground waters or down a hillside into a stream or nearby pond. Also, it has been found that many septic tanks installed for a one family dwelling may subsequently be utilized by several dwellings especially when housetrailers are placed on the same premises. The major chemical hazard at this time appears to be nitrates; however, we must keep in mind that most household chemicals that may be disposed of by way of the sewage system are poisonous to livestock and will also be in the overflow effluent.

The disposal of garbage, trash and waste materials are a problem in many urbanized rural communities. In many cases, the garbage, trash and other wastes are thrown into a nearby ravine that drains into a stream or into the stream itself. Again, the garbage may contain unused household chemicals, pesticides and detergents, and the waste materials may include used motor oil, paint, all sorts of metal containers and many other items containing hazardous chemicals. While the dilution factor may be great and the amount of pollution may seem small, this type of pollution is growing and is adding to the overall water pollution resulting from other sources.

The garbage and trash dumps of many small towns are situated in areas considered as waste land. In many cases the areas consist of ravines caused by erosion. In years passed, these areas served as trash and garbage dumps for the local residents and small businesses serving farm communities. Possible hazardous chemicals were not given serious consideration, and the number of hazardous chemicals many years ago that entered garbage was small in comparison to the present time because of the many chemicals that are used today that were not available a number of years ago. Also many small towns that mainly served farming communities have become industrialized and in many cases have industrial chemical wastes that are disposed of into the local garbage and trash dumps. Since many of the dump sites are situated in areas in which drainage into streams can occur, the streams receiving drainage from the dump becomes polluted with chemicals existing in the dump. As a result, farms downstream from the dump that utilize the stream as drinking water for their livestock may experience incidences of poisoning in their animals depending upon the amount of drainage from the dump and the amount of hazardous chemicals in the drainage water from the dump. Although it is generally considered by many that the small amount of hazardous chemicals draining from a dump of this kind is small and that the dilution factor after they enter the stream is thought to be well below the toxic level for livestock, the hazardous chemicals in the drainage water contributes to the overall pollution resulting from other sources.
Development of various types of industries and supporting businesses in and near small towns and farming communities has grown considerably during the last two decades. This has increased the demand for rural housing and various small businesses such as service stations and garages in the rural areas. Many small businesses of this nature are situated in places where water and waste products drain from the premises into adjacent fields and streams adding to the pollution of the streams used as drinking water for livestock on nearby farms. Cases of poisoning of livestock resulting from this type of pollution have been found to occur.

An investigation of cattle losses diagnosed as lead poisoning revealed that a service station and garage located on a hill was the source of the lead. The refuse oil drained from trucks and automobiles had been disposed of by pouring it on the ground in the rear of the garage over a long period of time. Water used to wash vehicles was also discharged from the back of the garage and flowed over the area covered with the oil and down hill into a stream. The stream was used by farmers downstream as drinking water for their cattle. The farm investigated had lost several cattle over a period of time having the appearance of severe malnutrition. The lead content of the stream from which cattle had been drinking water was between one and two parts per million. It was found to be the same at the point where drainage occurred from the garage, but negative upstream from the point of drainage from the garage.

In another case, a farmer lost a number of cattle as a result of acute arsenic poisoning. An investigation revealed that the source of the arsenic was from a garage on a hill overlooking his farm. The garage was the base for a fleet of trucks and trailers in the business of hauling various products from industrial plants over the United States including hazardous chemicals as an independent hauler. In this instance, one of the trucks had transported a trailer tank load of arsenic acid from a chemical plant in Texas to a pharmaceutical company in Iowa. The driver was supposed to have drained all of the residual arsenic acid from the trailer tank and have thoroughly cleansed it; however, he neglected to do so and drove to the base garage in Kentucky. The next morning, the trailer tank was cleansed of the residual arsenic acid which flowed down the hill into a pond used as drinking water for the farmer's cattle.

Many large industries have established plants in rural communities and small towns as well as nearby larger cities. Many of the larger industries have an environmental safety department that designs and institutes methods for the disposal of hazardous wastes. However, because of personnel carelessness or the inadequacy of the methods instituted, groundwaters and streams are polluted with their hazardous wastes.

A large dairy farm was experiencing losses of their dry cows and young heifers pastured in a field in which the drinking water for the cattle was a small creek. The cattle were unthrifty, lost considerable weight and appeared to be in a state of malnutrition. It was thought at first to be a mineral imbalance condition involving phosphorus even though a good maintenance ration was provided. When deaths occurred and autopsies
were performed, laboratory findings revealed lead poisoning. Upon investiga-
tion, it was found that the creek running through the field contained in
excess of 1.5 parts per million lead. It was also found that the banks of the
contributing stream contained a black greasy residue. The source of the
grease and lead originated from a battery plant and that one of the
employees had been dumping waste water from one of the plant's operation
down a storm sewer that emptied into the creek instead of disposing of it in
accordance with the company's instructions.

In another case, a saddle horse farm had been experiencing a condition
in their horses over a period of four to five years. The horses were unthrifty,
experienced frequent colics, a number were blind, without evidence of
inflammation, a number of cases of iridocyclitis, a number of them had
difficulty in breathing when ridden, heave lines were prominent in several
and some had difficulty in swallowing. Some of the mares gave birth to
deformed foals. Terminal cases became incoordinated, had severe symp-
toms of colic and died in a state of convulsions. During this time the horses
would appear to improve for a period of time giving the owner encourage-
ment that the illness in the horses was over; however, the horses would
again become unthrifty and losses would occur. Over this period of time
several veterinarians had examined the horses giving various opinions as
to the nature and cause of the disease condition including malnutrition,
parasitism, equine infectious anemia and various types of poisoning.

The last veterinarian employed by the owner of the horses was sure it
was some type of poisoning and requested an investigation to determine
the cause. Upon clinical examination and examination of blood samples of
20 of the horses, lead poisoning was confirmed. Most of the blood lead
values were in excess of 1.00 part per million. The source of the lead was
determined to be from the drinking water which fluctuated in con-
centration from day to day from acceptable levels to over 1.0 part per
million. The drinking water for the premise was from a spring that had
prescribed filters for sanitary purposes. The water was pumped from the
spring house to the barns, house and watering troughs for the horses. Other
springs on the farm and on other premises in the area were also
examined and were found either to be free of lead or to contain lead within
acceptable limits for drinking water.

The only industrial plant that could possibly be a source of lead was a
truck assembly plant two miles south of the farm. The streams and springs
in the farm and plant vicinity flowed from south to north. It was revealed
that the truck assembly plant used lead base paints to paint the trucks and
used lead solution to anodize parts of the trucks. Waste lead solutions were
transferred to waste lagoons built for the purpose on the plant premises. It
was indicated that cracks had developed in the floor of the waste lagoon. A
geological engineer determined that the spring used as drinking water at
the horse farm flowed underneath the waste lagoon, and the waste waters
from the lagoon could seep into the spring channel supply.

The great increase in automobile and truck travel on our rural highways has also caused pollution of many streams that run through farmlands and are utilized as sources of drinking water for livestock. In past years and at the present time leaded gasoline is used to power the majority of vehicles traversing the highways. The exhaust fumes contain a considerable amount of lead in the form of particulate lead and lead oxides as combustion products of the leaded gasoline which are deposited on the roadway, ditches and adjacent fields and streams. While some of the particulate lead and lead oxides are deposited in the streams along the highways, most is on the highway, ditches and on the adjacent grounds. However, it is believed that rains was a good amount of the lead from the highways and vegetation into the ditches and drain into the nearby streams thereby polluting the stream with lead deposits.

Lead oxides are not soluble in neutral or acid waters, but they may combine with basic metals such as sodium, potassium and calcium to form soluble metal plumbates under basic conditions. Most of the lead oxides and metallic lead would sink to the bottom of the stream bed and slowly convert into soluble lead compounds.

Two horse farms were experiencing a problem in their horses consisting of an unthrifty condition, poor hair coats and a few that became blind. Lead poisoning was suspected and confirmed by the examination of blood levels conducted on several of the horses on each farm. Also, raccoons and foxes from each farm having central nervous symptoms were submitted for rabies examinations which were found to be negative for rabies. Further examination revealed that lead poisoning was the cause of their disease condition.

An investigation of the premises did not reveal a source of lead to which the horses could be exposed other than streams near highly traveled highway. The stream waters were found to contain in excess of 1.0 part per million lead at the time of the investigation. The small streams flowed into a large creek that passed through each premise. Upstream from the horse farms the creek meandered around a large city near industrial plants and through suburban areas. The farms had fenced along the creek to prevent their livestock from having access to it because they considered it to be polluted. Measurements of water from several points along the creek revealed lead concentrations of 1.5 parts per million. It was also noted that the stream and its banks were devoid of marine life, such as crayfish.

There are a number of requests for investigations made by farmers experiencing livestock illnesses and losses that believe the illnesses and losses are the result of chemical pollution of streams and ponds in their pastures used for drinking water for their animals. In such cases, the investigator must have the animal owner remove his animals from the suspected source of possible poisoning, determine the nature of the illness and secure specimens of the water under suspicion for possible toxicologic examination.
A chemical spill occurred at a small industrial plant and drained into a creek that ran through livestock farms and was used as a source of drinking water for their livestock. Following the spill, a number of the cows on one of the farms aborted their fetuses. The farmer felt that the reason for the abortions was the chemical that polluted the creek. Upon investigation, it was found that a petroleum distillate similar to kerosene used in their manufacturing process was the ingredient of the spill. Since some lead and nitrates used in the plant could be in the distillate, lead and nitrate were considered. Examination of the water did not reveal the presence of any agents in concentrations of toxicologic significance. Blood samples taken from the cows that had aborted were negative for lead and nitrates; however, serological tests for infectious agents that may cause abortion in cows were positive for brucellosis.

A number of cases of livestock illnesses and deaths involving possible pollution of farm ponds resulting from chemicals used on adjacent fields by neighbors, gas line companies, and power companies have often been reported. After an investigation in most cases, the illness and losses are found to have resulted from some other cause such as blue green algae poisoning or infectious diseases.

In conclusion, it is evident that the many changes occurring in our livestock farming communities are providing many sources for the pollution of streams, springs and ponds; the waters of which are utilized as drinking water for livestock and in some cases for man. It appears that there are very few control measures instituted at this time in an effort to prevent the pollution of streams and springs in rural farming communities in many parts of the country. While chemical pollution of streams, springs and ponds was a minimal problem a few years ago, it is becoming a serious problem at this time and is steadily increasing.
INTRODUCTION

Today's Veterinarian is called upon to apply his training and expertise in many areas of public health. To fulfill this expanded role he must maintain a current knowledge in traditional areas of veterinary medicine, and acquire more than a speaking acquaintance with many other disciplines in the broad spectrum of health care. He must maintain an awareness of new development in chemical and manufacturing procedures, and be cognizant of expansive legislative acts on the local, state and national level; some of which are changing the health components of urban and rural America.

With the passage of the Clean Air Act (the Act) of 1970, and its 1977 Amendments, a long standing national commitment to improve the quality of the ambient air in America had been taken. The Environmental Protection Agency (EPA) was created by Congress to enforce the Act. Its Administrator is mandated, by Section 109 of the Clean Air Act, to prescribe primary and secondary National Ambient Air Quality Standards (NAAQS), based on criteria documents developed by EPA.

Section 110 of the Act mandates that each state submit a State Implementation Plan (SIP) which provides for implementation, maintenance and enforcement of NAAQS to EPA for approval; EPA maintaining dual jurisdiction. In that capacity, EPA promulgated the concept of Best Available Control Technology (BACT) for air pollution sources. These standards, while requiring the use of state-of-the-art technology, recognized that practical limitations did exist on air pollution control at its source. Unfortunately, BACT standards were then displaced by more stringent standards, Lowest Achievable Emission Rate (LAER). LAER standards, in conjunction with the “Bubble” concept of collective area pollution output, was a major factor in the dispersion of manufacturing and production plants into rural areas previously unaffected by large scale manufacturing establishments. This, coupled with transportation shifts from rail to truck hauling and the remarkable growth in chemical/technological advances, placed suburban and rural America in jeopardy of accidental exposures to raw materials and waste products unknown to the general population of 10 years ago.

Many potentially harmful chemicals which could become airborne in a rural or suburban incident are either colorless gases or dusts, some radioactive, which rapidly disburse into invisible plumes from their emission source. It is not inconceivable that a practicing veterinarian could find...
himself rapidly and deeply involved in health care decisions related to an accidental spill or rupture of serious potential.

Generally speaking, the specific chemical composition, as well as its concentration, is readily obtainable from the carrier vehicle, its manufacturer, or its proposed recipient. Concentrations which may be considered harmful to man, animals, plants or human possessions are obtainable from many sources (health agencies, medical centers, colleges, federal agencies, manufacturers, etc).

What is not so readily available is rapidly determining the area downwind from the source in which potential harm may result from immediate or extended exposure. One method of determining a working area of potential hazard is by utilizing the modified Wind Dispersion Equation(s) of O.G. Sutton, et al.

Modifications of Sutton's original turbulence equation, substituting standard deviations for his dispersion parameters, have resulted in a generally accepted model for estimating downwind ambient air pollution concentrations (gas, or particles less than 20 microns). The equation becomes:

\[
X(x,y,z;H) = \frac{Q}{2\pi \sigma_y \sigma_z U} \exp \left[ \frac{-1}{2} \left( \frac{y}{\sigma_y} \right)^2 \right] \left\{ \exp \left[ \frac{-1}{2} \left( \frac{z-H}{\sigma_z} \right)^2 \right] \exp \left[ \frac{-1}{2} \left( \frac{z+H}{\sigma_z} \right)^2 \right] \right\}
\]

Where \( X \) = pollution concentration in g/M\(^3\) (or ug/M\(^3\))
- \( Q \) = emission rate in g/sec.
- \( U \) = average wind speed in M/sec.
- \( \sigma_y \) = diffusion coefficients in y direction, meters.
- \( \sigma_z \) = diffusion coefficients in z direction, meters.
- \( H \) = effective height of pollution source, meters.

Pasquill (2) and Gifford (3) developed a procedure for making dispersion estimates, utilizing this modified equation, in 1961. The procedure considered the pollution source at or below the point of emission, with the x-axis extending horizontally with the mean wind direction. The y-axis is horizontally perpendicular to the x-axis, and the z-axis extends vertically. The plume spread has a Gaussian distribution in both the horizontal and vertical planes, with standard deviations of plume concentration distribution in the horizontal and vertical of \( \sigma_y \) and \( \sigma_z \) respectively. It is assumed that there is no diffusion in the x direction, i.e., the plume release is continuous, or that the duration of release is equal to or greater than the travel time from source to point of interest.

\( H \) is the height of the plume centerline when it becomes essentially level, and is the sum of the physical stack height h, and the plume rise above the stack. The mean wind speed affecting the plume is U; the uniform emissions rate of pollutants is Q; and total reflection of the plume occurs at the earth's surface, i.e., no deposition or reaction at ground level. The concept may be visualized in Figure 1.
Turner (4) developed a key to stability categories for both night and day which permit the selection of the appropriate $\sigma_Y$ and $\sigma_Z$ for horizontal and vertical dispersion coefficients. Table 1 consists of five stability categories, A (most unstable) through F (most stable) based on wind speed in m/sec$^{-1}$ at an elevation above ground level of 10 M. Daytime categories are predicated upon subject determinations of strong, moderate and slight incoming solar radiation.

**TABLE 1**

**KEY TO STABILITY CATEGORIES**

<table>
<thead>
<tr>
<th>Surface Wind speed (at 10m), m sec$^{-1}$</th>
<th>Day</th>
<th>Night</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>A</td>
<td>-</td>
</tr>
<tr>
<td>2-3</td>
<td>A-B</td>
<td>-</td>
</tr>
<tr>
<td>3-5</td>
<td>B</td>
<td>-</td>
</tr>
<tr>
<td>5-6</td>
<td>C</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>C</td>
<td>-</td>
</tr>
</tbody>
</table>

The neutral class, D, should be assumed for overcast conditions during day or night. Source: Turner, 1970.
Night time categories are divided into $\geq 4/8$ cloud cover, and $\leq 3/8$ cloud cover. A choice of the most appropriate stability category (A through F) is made, based on wind speed and night/day subdivisions.

Having selected the appropriate stability category, a numerical value for $\sigma_y$ may be determined by locating the downwind distance of interest on the x-axis of Figure 2, tracing it vertically until it intersects with the appropriate stability category dotted line, then following a horizontal line from that point to the y-axis; $\sigma_y$ may then be determined in meters.

Figure 2. Horizontal dispersion coefficient as a function of downwind distance from the source. (Turner, 1970)
\( \sigma_y \) may be determined in a similar manner from Figure 3.

Figure 3. Vertical dispersion coefficient as a function of downwind distance from the source. (Turner, 1970)

These methods give representative coefficient over open country or rural areas, but are less reliable for urban areas due to relative surface roughness and the heat island effects found in cities.

It is important to recognize that this model is only one of several possible models of Gaussian behavior, but when best estimate, not infallible prediction, is sufficient, this model may be programmed for the Texas Instrument Programmable 59 and stores on magnetic tape for quick recall. The program is as follows:
A PROGRAM FOR THE TEXAS INSTRUMENT 59 CALCULATOR

000 76 LBL 052 95 = 104 45 Y^x
001 11 A 053 55 ÷ 105 43 RCL
002 42 STO 054 43 RCL 106 11 11
003 01 01 055 06 06 107 95 =
004 91 R/S 056 95 = 108 42 STO
005 76 LBL 057 33 X2 109 14 14
006 12 B 058 55 ÷ 110 43 RCL
007 43 STO 059 02 2 111 09 09
008 02 02 060 94 +/- 112 45 Y^x
009 91 R/S 061 95 = 113 43 RCL
010 76 LBL 062 42 STO 114 12 12
011 13 C 063 10 10 115 95 =
012 42 STO 064 43 RCL 116 42 STO
013 03 03 065 03 03 117 15 15
014 91 R/S 066 75 = 118 43 RCL
015 76 LBL 067 43 RCL 119 15 15
016 14 D 068 04 04 120 65 X
017 42 STO 069 95 = 121 53 ( )
018 04 04 070 55 ÷ 122 43 RCL
019 91 R/S 071 43 RCL 123 13 13
020 76 LBL 072 06 06 124 85 +
021 15 E 073 95 = 125 43 RCL
022 42 STO 074 33 X^2 126 14 14
023 05 05 075 55 ÷ 127 54 ( )
024 91 R/S 076 02 2 128 95 =
025 76 LBL 077 94 +/- 129 42 STO
026 16 A' 078 95 = 130 16 16
027 42 STO 079 42 STO 131 53 ( )
028 06 06 080 11 11 132 43 RCL
029 91 R/S 081 43 RCL 133 08 08
030 76 LBL 082 02 02 134 55 ÷
031 17 B' 083 55 ÷ 135 53 ( )
032 42 STO 084 43 RCL 136 02 2
033 07 07 085 05 05 137 65 X
034 91 R/S 086 95 = 138 89 τ
035 76 LBL 087 33 X^2 139 65 X
036 18 C' 088 55 ÷ 140 43 RCL
037 42 STO 089 02 2 141 05 05
038 08 08 090 94 +/- 142 65 X
039 91 R/S 091 95 = 143 43 RCL
040 76 LBL 092 42 STO 144 06 06
041 19 D' 093 12 12 145 65 X
042 42 STO 094 43 RCL 146 43 RCL
043 09 09 095 09 09 147 07 07
044 91 R/S 096 45 Y^x 148 54 ( )
045 76 LBL 097 43 RCL 149 54 ( )
046 10 E' 098 10 10 150 65 X
047 43 RCL 099 95 = 151 43 RCL
048 03 03 100 42 STO 152 16 16
049 85 ÷ 101 13 13 153 95 =
050 43 RCL 102 43 RCL 154 91 R/S
051 04 04 103 09 09
To enter this program into the TI 59 calculator, press 2nd CP LRN, and enter the program from 000 76 LBL thru 154 91 R/S. Press LRN, which closes the program. By pressing 1 2nd Write and passing a magnetic tape through the calculator, the program is recorded on tape for future use.

To reprogram the TI 59 at a later date for wind dispersion estimations, press CLR and pass the programmed tape thru the calculator. A sample problem would be entered as follows:

The stability category which best fits today's weather is D. The point of interest downwind on the x-axis is 1,000 meters.

STEP 1. enter 1,000; press A.
The perpendicular point of interest on the y-axis is 200 meters.

STEP 2. enter 200; press B.
The vertical point of interest on the z-axis is 100 meters.

STEP 3. enter 100; press C.
The effective stack height, H, is 100 meters.

STEP 4. enter 100; press D.
$\sigma_y$ based on stability category D and 1,000 meters downwind, is found to be 70 meters on Figure 2.

STEP 5. enter 70; press E.
$\sigma_z$ based on stability category D and 1,000 meters downwind, is found to be 32 meters on Figure 3.

STEP 6. enter 32; press 2nd A'.
The appropriate value for U is the average wind speed in meters/second through the stack plume. More commonly, an estimate is made, based on an assumed velocity profile, i.e.,

$$U = U_1 \left( \frac{H}{Z_1} \right)^n$$

where:

- $U_1 =$ wind speed at top of wind tower, M/sec
- $H =$ effective stack height, meters
- $Z_1 =$ height of wind tower used to measure $U_1$ meters
- $N = 0.25$ for unstable condition; $N = 0.50$ for stable condition

Wind speed for today measured from a 10M tower is found to be 5M/sec:

$$U = 5 \frac{(150)}{10} 0.37$$

$$U = 13.6 \text{ M/sec.}$$

STEP 7: enter 13.6; press 2nd B'.

Q, the pollutant concentration in ug/sec., is $1.075 \times 10^9 \text{ ug/sec.}$

STEP 8: enter $1.075 \times 10^9$; press 2nd C'.

Exp = base of natural logarithm, 2.718281828

STEP 9: enter 1; press INV 1nx 2nd D'.

STEP 10: press 2nd E; to run program.
The pollutant concentration, 94.801 ug/M³, will appear at the end of the program run.

Since any value in STEPs 1 thru 8 may be modified by simply entering
new data over the old, WITHOUT AFFECTING THE OTHER STEP VALUES, it is possible to rapidly calculate the projected concentration for multiple points downwind from a pollution source.

REFERENCES

PUBLIC HEALTH ASPECTS OF VESICULAR STOMATITIS IN COLORADO DURING THE 1982-1983 EPIDEMIC

Donald R. Bridgewater, D.V.M., M.P.V.M.
United States Department of Agriculture
Animal Plant Health Inspection Service
Veterinary Services
(USDA, APHIS-VS)

INTRODUCTION

The United States Department of Agriculture, Animal Plant Health Inspection Service, Veterinary Services (USDA, APHIS-VS) has a policy and first responsibility when dealing with reported cases of vesicular conditions in cloven-hooved livestock to make a differential diagnosis to determine whether or not the condition is due to Foot-and-Mouth Disease (FMD) or some other vesicular disease. In July 1982, investigations conducted by APHIS-VS Foreign Animal Disease (FAD) Diagnosticians of a vesicular condition in cattle and horses in Colorado revealed a differential diagnosis of Vesicular Stomatitis (VS). Once VS was confirmed, FAD Diagnosticians immediately alerted practicing veterinarians and the livestock industry to the public health aspects of the disease. The Colorado Department of Health was also alerted.

HISTORY

A vesicular condition involving cattle in Arizona reported to APHIS-VS and investigated by FAD Diagnosticians was laboratory confirmed on June 2, 1982, by serological tests to be VS, New Jersey (NJ) Type. Later, a positive VS, NJ Virus isolation from this case was laboratory confirmed on June 16, 1982. Once confirmed in Arizona, the Vesicular Stomatitis Virus, (VSV), NJ Type continued up the intermountain states to affect cattle and horses in New Mexico, Utah, Colorado, Wyoming, Idaho, Montana, and South Dakota. It also occurred in Washington, Missouri, Oregon, Kansas, Nebraska, and California. This resulted in one of the largest VS epidemics ever recorded in the United States. Fourteen states had confirmed cases of VS (Figure 1). Epidemiological evidence indicated that the latter six states were initially involved as the result of affected and/or exposed livestock being moved interstate from infected herd(s). Epidemiological evidence also indicated that contact animal-to-animal spread caused cases in cattle that occurred after killing frosts. The possibility of recrudescence due to latent VS infection became apparent when previously affected and recovered livestock developed new lesions following their movement to a new location.

A vesicular condition investigated in Colorado was laboratory confirmed by serological tests to be VSV, NJ Type on July 22, 1982. A positive NJ VSV isolation was later laboratory confirmed in Colorado on August 3, 1982. Disease reporting records in Colorado indicated that VS affected
IN COLORADO DURING THE 1982–1983 EPIDEMIC

cattle and horses in widely separated areas without any epidemiologically associated evidence to indicate contact spread with other animals due to movements of affected or exposed livestock. The course of the disease seemed to be uncertain. Vesicular Stomatitis appeared to move from the south up the desert belt between Utah and Colorado to the north. Earlier non-confirmed cases point to the fact that it initially affected cattle and horses in southwestern Colorado around the latter part of June or the first part of July. In about 30 days, VS was confirmed in livestock in northwestern Colorado approximately 300 miles to the north. Periodically, cases were reported on the eastern slope at about the same time. During the epidemic, APHIS-VS confirmed VS in 33 of 63 counties in Colorado (Figure 2).

To more readily investigate premises where it had been reported that cloven-hooved livestock were exhibiting vesicular conditions, a task force was activated in Colorado in July. A field office was established in Durango on July 28, 1982. A few days later a field office was established in Grand Junction. The Task Force Headquarters was established in the USDA, APHIS-VS office located in Denver. Practitioners were Veterinary Services' best source for reports of livestock exhibiting vesicular conditions. Disease reporting was continually encouraged so that State-Federal FAD Diagnosticians could investigate involved premises, examine affected livestock, and obtain necessary laboratory specimens for a differential diagnosis. Most specimens collected were sent to USDA, APHIS, National Veterinary Services Laboratories (NVSL), Ames, Iowa, for testing. Highly suspicious FMD specimens were transported by courier to the USDA, Agricultural Research Service, Plumb Island Animal Disease Center, Greenport, New York, for testing. All tests for FMD conducted by both laboratories were negative. Vesicular Stomatitis, NJ Type, was provided by NVSL as a differential diagnosis supporting FAD Diagnosticians in ruling out a diagnosis of FMD.

PUBLIC HEALTH

Once VS was confirmed by APHIS-VS to be responsible for the vesicular epidemic condition occurring in livestock in Colorado, veterinary practitioners and the livestock industry were alerted to the public health aspects of the disease. This notification was initially accomplished by FAD Diagnosticians in conjunction with their premises investigation. The news media began to insist on information. Task Force Headquarters and both field offices provided current information to the television, radio, and press. The Colorado Task Force Headquarters also alerted the Colorado Department of Health. They too made periodic releases to the news media. One physician, concerned about the public health significance of VS, reported to the Grand Junction Field Office an apparent increase in human influenza. Vesicular Stomatitis in man has been well documented in the literature. It appears in man as an acute self-limiting infection. The signs and symptoms are similar to those of influenza in man. Vesicular Stomatitis in man has most commonly been reported as a laboratory-
associated type infection. It is, however, transmissible to man under natural conditions. It should, therefore, from a public health aspect be differentiated from clinically similar diseases.³

On August 3, 1982, the Task Force Headquarters received from the Grand Junction field office a report of suspected VS in a human. The report had been received from a practicing physician in the Grand Junction area who was aware of the VS epidemic. The person involved was a female who worked in a dairy as a milker. She was experiencing vesicular lesions of the mouth and foot. The physician obtained a serum sample, vesicular fluid, and a throat swab from this individual on August 4. These specimens were sent to NVSL, Ames, Iowa, via the Grand Junction field office. The results on these specimens were reported to Veterinary Services and the physician to be negative for VS. Convalescent specimens were not obtained from this individual. Because of public health awareness, eight more suspected human cases, not involving veterinarians, were reported to the Grand Junction field office in August by physicians. They reported that their patients were either exhibiting signs of human influenza or had been exposed to livestock suspected of having VS. They were all suspected occupationally related cases. Some human exposures were related to the treatment of livestock suspected of having VS. Paired sera samples were submitted for three of these individuals. They were reported to be negative. Acute sera samples were submitted on the remaining five individuals. They, too, were reported to be negative. (Table 1).

Recognizing the public health significance of the disease, most FAD Diagnosticians wore disposable surgical gloves while examining and obtaining specimens from suspected livestock. On August 4, 1982, the Task Force Headquarters received a report from the Durango field office that an APHIS-VS FAD Diagnostican was exhibiting suspected symptoms of VS. His symptoms were those of influenza, and he had non-vesicular mouth lesions that he described as erythematous, swollen, tender, and painful. They were limited to the hard palate and internal surface of the lip. This individual submitted an acute serum sample early in August to NVSL and a convalescent serum sample early in September. The acute sample was reported by NVSL to be negative to the complement-fixation (CF) test and the serum neutralization (SN) test. The convalescent sample was reported to be CF positive at 1:20 and SN positive at ≥1:512. The NVSL considers complement-fixing antibody titers non-significant at 1:5 and titers of 1:20 or greater indicative of recent infection with the New Jersey VSV. They also report that virus-neutralizing titers of 1:32 or greater are indicative of previous exposure to the VSV. In this individual with paired sera samples, the negative acute SN test compared to the significantly high convalescent SN Titer was indicative of recent exposure to the VSV. Later in August, the Task Force Headquarters received from the Grand Junction field office a report of a suspected vesicular lesion on the thumb of a practicing veterinarian. This individual had cut his thumb earlier during surgery
and later examined a horse suspected of having VS. This individual submitted an acute serum sample to NVSL in August and a convalescent serum sample early in September. The acute sample was reported by NVSL to be negative to the CF test and positive at 1:128 to the SN test. The convalescent sample was reported to be positive to the CF test at 1:10 and positive to the SN test at 1:128. Identical SN titers are an indication that this veterinarian had previous but not-recent exposure to the VS virus. Perhaps the vesicular lesion on the thumb was due to recent exposure but did not result in an increase in SN titer.

Foreign Animal Disease Diagnosticians and APHIS-VS Animal Health Technicians (AHT) conducting premises investigations were thought to be at high risk. Task Force personnel were therefore requested by APHIS-VS to contact a physician of their choice and submit paired sera samples to NVSL for VS testing. During the epidemic twelve FAD Diagnosticians and seven AHT’s were actively engaged in conducting premises investigations. Paired sera samples were submitted by six FAD Diagnosticians. These veterinarians reported having experienced symptoms of influenza. Three had acute sera that were reported to be negative. However, their convalescent sera showed increased SN titers indicative of recent exposure to the VS virus. One of these stated that while he was collecting samples from the mouth of a cow she snorted and threw her head. This caused saliva and exudate to be thrown into his face and eyes. Four days later he became sick. In this situation the use of disposable surgical gloves would not have prevented exposure. Since FAD Diagnosticians are at an apparent high risk to the VSV, perhaps face shields should be provided to them. Face shield are routinely used by laboratory workers when working with the VSV. One individual’s paired sera was reported as having positive SN titers. The convalescent SN titer, however, was only slightly higher than the acute SN titer indicative of previous and not-recent exposure to the VSV. Two had negative paired sera. Three FAD Diagnosticians reported not being sick and did not submit sera samples. One FAD Diagnostician reported not being sick, but submitted only a convalescent sera sample that was reported to be negative. Two FAD Diagnosticians did not respond to the request. Only two AHT’s reported having experienced symptoms of influenza. They submitted paired sera that were reported to be negative. Three reported not being sick but submitted only acute sera that were reported to be negative. One reported not being sick and did not submit sera. One AHT did not respond to the request (Table 2).

**DISCUSSION**

Out of 26 VS occupationally-related reports in Colorado during the 1981-1983 VS epidemic, paired sera were submitted from 12 (46%) of these individuals that had experienced symptoms of human influenza. Three of 12 (25%) revealed complement-fixing and/or virus-neutralizing antibodies indicative of recent exposure to the VSV. These were FAD Diagnosticians. Two of 12 (17%) revealed complement-fixing and/or virus-neutralizing antibodies indicative of previous exposure to the VSV. One was a FAD
Diagnostician and one a practicing veterinarian. Seven of 12 (58%) had VSV negative paired sera indicating no recent or previous exposure to VSV. This indicated the influenza symptoms were caused by something other than VS. The remaining 14 of 26 (54%) lacked specimens and/or paired sera, so a diagnostic determination could not be made.

REFERENCES

2. Henry, P. R., Ibid. p. 277
Figure 1.
USDA, APHIS-VS USDA, APHIS-NVSL
Emergency Programs - Vesicular Stomatitis
States with Infected Herds
February 1983

Figure 2.
USDA, APHIS-VS USDA, APHIS-NVSL
Premises Investigations for Period June 24 Through September 21, 1982

Vesicular Stomatitis laboratory confirmed in cattle and horses
Table 1.

PHYSICIANS' HUMAN SUBMISSIONS 1982
COLORADO VESICULAR STOMATITIS OUTBREAK USDA, APHIS, VS - USDA, APHIS, NYSL

<table>
<thead>
<tr>
<th>COUNTY</th>
<th>PAIRED SAMPLES</th>
<th>CLINICAL SYMPTOMS</th>
<th>ACUTE TEST</th>
<th>CONVALESCENT TEST</th>
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</thead>
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<tr>
<td>MESA</td>
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<td>NEG</td>
</tr>
</tbody>
</table>

*Division of Vector-Borne Viral Diseases
Center for Infectious Diseases
Center for Disease Control
Ft. Collins, CO
Table 2. TASK FORCE PERSONNEL ASSIGNED TO 1982 COLORADO VESICULAR STOMATITIS OUTBREAK USDA, APHIS, VS - USDA, APHIS, NVSL

<table>
<thead>
<tr>
<th>PERSONNEL</th>
<th>CLINICAL SYMPTOMS</th>
<th>TESTED</th>
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</table>

** - YES | YES | NEG | NJ | NJ | NJ |

FAD - Foreign Animal Disease
AHT - Animal Health Technician
NJ - New Jersey Positive

Division of Vector-Borne Viral Diseases
Center for Infectious Diseases
Ft. Collins, Colorado
Practicing Veterinarian
REPORT OF THE COMMITTEE ON PUBLIC HEALTH AND ENVIRONMENTAL QUALITY

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The Committee on Public Health and Environmental Quality met at 1:30 p.m., Wednesday, October 19, 1983 as scheduled. A total of 11 committee members and 7 guests were in attendance.

Dr. Paul Siburt reported on the occurrence, environmental impact and animal and human health implications of dioxin. Dioxins are a group of compounds that form during the manufacture of 2, 4, 5-T and are contaminants of commercial 2, 4, 5-T products. Certain dioxins are highly toxic to man and animals; however, their effects appear to differ between species. The main lesions found in man are skin lesions and in some cases an enlarged liver. Long term studies made on people heavily exposed as a result of plant accidents revealed numerous cases of chloracne and only transient toxic liver conditions. See copy of Dr. Siburt’s report attached hereto. Dr. C. D. Stumpff reported on the public health aspects of Bovine Tuberculosis during 1983.

The purpose of this paper is to update current problems during 1983 year. Even though the Bovine Tuberculosis eradication program is in its apparent final phase, sporadic outbreaks still occur. Three such events that occurred in 1982 are as follows:

1. **Wisconsin**—several dairy herds have recently been disclosed or infected. Public Health aspects are currently under evaluation.
2. **Texas**—at least one dairy herd has been determined to be infected with Bovine Tuberculosis. Public health aspects are currently being investigated. This herd is located in the El Paso area close to the Mexico/U.S. boundary. At the present time it appears that movement of cattle from Mexico has occurred. Mexico reportedly has a high rate of Bovine Tuberculosis.
3. **Mississippi**—a large dairy herd was found to be infected in Northern Mississippi. This is a herd consisting of 800 dairy cattle held in confinement and subjected to three times a day milking. Twenty-five persons associated with this dairy were tested. Eight responded to an intradermal tuberculin test. One person had lung lesions on chest X-ray and M. Bovis was subsequently isolated from bronchial secretions.

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Dr. Donald R. Bridgewater reported on the public health aspects of Vesicular Stomatitis in Colorado during the 1982–1983 epidemic.

PUBLIC HEALTH

Once VS was confirmed by APHIS as being responsible for the vesicular epidemic condition occurring in livestock in Colorado, veterinary practitioners and the livestock industry were alerted to the public health aspects of the disease. One physician, concerned about the public health significance of VS, reported to the Grand Junction Field Office an apparent increase in human influenza. Vesicular Stomatitis in man has been well documented in the literature. It appears in man as an acute self-limiting infection. The signs and symptoms are similar to those of influenza in man. Vesicular Stomatitis in man has most commonly been reported as a laboratory-associated type infection. It is, however, transmissible to man under natural conditions. It should, therefore, from a public health aspect be differentiated from clinically similar diseases.

The Task Force Headquarters received from the Grand Junction field office a report of suspected VS in a human. The person involved was a female who worked in a dairy as a milker. She was experiencing vesicular lesions of the mouth and foot. The physician obtained a serum sample, vesicular fluid, and a throat swab from this individual. These specimens were sent to NVSL, Ames, Iowa, via the Grand Junction field office. The results on these specimens were reported to Veterinary Services and the physician to be negative for VS. Convalescent specimens were not obtained from this individual. Because of public health awareness, eight more suspected human cases, not involving veterinarians, were reported to the Grand Junction field office in August by physicians. They reported that their patients were either exhibiting signs of human influenza or had been exposed to livestock suspected of having VS. They were all occupationally related cases. Some human exposures were related to the treatment of livestock suspected of having VS. Paired sera samples were submitted from three of these individuals. They were reported to be negative. Acute sera samples were submitted on the remaining five individuals. They, too, were reported to be negative.

Dr. Jeff Farrar reported the results of a survey made of livestock producers in Minnesota to determine the producers' knowledge and attitude toward medicinal and chemical residue control in meat and dairy products and their knowledge and attitude as producers participating in residue avoidance. The survey revealed that a great majority of the producers were very knowledgeable of the residue problem and followed recommendations, and favored the program's efforts to prevent harmful residues from entering the food chain. A few dissenters were also noted. Most of the producers felt that their best source of information concerning residues is their local veterinarian and the instructions provided for the use of medicated feeds by the manufacturer.
The Sub-Committee on Future Challenges and Concerns in Public Health report was presented by Dr. S. L. Diesch.

With the discontinuation of commercial production by Jensen Salisbury Laboratory of their ERA strain rabies vaccine, there is no available rabies vaccine approved by USDA for use in the equine species. This is a national problem and is especially serious in the Eastern states where a raccoon rabies epidemic is occurring. The new diploid cell origin killed rabies vaccine is approved for cattle, but not for equine and is distributed by Merieux Laboratory. Rabies vaccination of horses is practiced using other rabies vaccines even though they have not been evaluated in horses and this use is not included on the label. Commercial biological companies should be encouraged to develop and market rabies vaccines approved for the equine species.

There has been a remarkable occurrence of vesicular stomatitis in cattle in the Western states. Vesicular stomatitis is a possible zoonotic disease. The vesicular stomatitis virus can be transmitted from cattle to man producing cutaneous lesions. Due to the infrequency of occurrence of VS in human beings, many physicians may not recognize the condition. Therefore public health agencies and medical organizations should be made aware of the presence of vesicular stomatitis virus in their area and the procedure for diagnosis of zoonotic infections in man.

Pilot studies of a National Animal Disease Surveillance Systems have been implemented in Ohio and Tennessee. Plans are that this surveillance system will cover the United States by 1989. This surveillance is based on the methodology developed as a result of the Minnesota Food Animal Disease Reporting System. It is based on a statistical random sample of farmsteads.

Reliable information on zoonotic diseases, toxicological problems and aspects of management will be available. This system will have an economic base to support prevention, control and eradication of diseases and conditions of animals. This information system will generate information that can and should be utilized by professionals on improvement of public health and environmental quality.

The Committee recommended that there should be more emphasis placed upon the public health aspects of zoonoses and information disseminated to the state animal health officers and practicing veterinarians who should develop a closer liaison with public health officials.

DIOXIN
IT'S OCCURRENCE, ENVIRONMENTAL IMPACT AND ANIMAL AND HUMAN HEALTH IMPLICATIONS

Dioxin, 2,3,7,8 – tetrachlorodibenzo – p – dioxin (2,3,7,8 – TCDD is a chemical contaminant associated with the manufacture of phenoxyacid herbicides, particularly (2,4,5, – T) 2,4,5, – trichlorophenoxy acetic acid.

2,4,5, – T has been produced as a registered pesticide in the United States since 1948. According to EPA records 122 companies had Federal
registrations and formulated 424 registered products. U.S. production in 1970 was 12,335,000 pounds, and an additional 739,000 pounds were imported during 1971 through 1974. Approximately 50 million pounds were exported during this same period.

During the first step in the manufacturing process of 2,4,5, - T, if temperature and pressure are not carefully controlled, highly toxic contaminants, polychlorinated dibenzo-p-dioxins, may be formed in large quantities. The particular dioxin formed is dependent on the chlorophenols present. The term dioxin does not apply to any one compound but to a group of related substances, which are distinguished by the number and orientation of chlorine atoms they contain. Dioxin toxicity also varies with the position and numbers of chlorines attached to the phenol rings.

In the 2,4,5, - T manufacturing process an especially toxic dioxin, 2,3,7,8 tetrachlorodibenzo-p-dioxin (TCDD), is formed when the reaction temperature is excessive, most commonly at temperatures above 180° C. Halogens at the 2,3, and 7 positions are known to produce toxic dioxins. In the case of TCDD, the chlorine atoms are attached at the 2,3,7, and 8 positions which are considered the most toxic positions possible. The dioxin contaminant in 2,4,5, - T is of particular concern because of its extremely high toxicity, and because of the apparent inability of manufacturers to produce 2,4,5, - T without the contaminant, TCDD.

At one time 2,4,5, - T was produced which contained from 30 to 40 parts per million. Currently commercial production contains on an average of about 0.01 part per million.

The herbicide 2,4,5, - trichlorophenoxyacetic acid (2,4,5, - T) is used throughout the world to control woody plants on rangelands and rights of way, to eliminate the competition of hardwoods in pine forests, and to control herbaceous weeds in rice culture. On February 28, 1979 Douglas Costle, the administrator of the U.S. Environmental Protection Agency, suspended the use and manufacture of 2,4,5, - T and silvex. The reason for the suspension was the concern over a contaminant, 2,3,7,8 - Tetrachlorodibenzo-dioxin (2,3,7,8 - TCDD or dioxin), present in the two compounds. The contaminant is suspected to be a human teratogen (causing birth defects) and an oncogen (causing tumors) and a teratogen to test animals.

According to Morgan (1976), 2,4,5, - T has a low toxic potential with an oral LD$_{50}$ for rats of 500 mg/kg of body weight. Humans have tolerated 0.5 gm doses ingested daily for two to four weeks without adverse effects. 2,4,5, - T and its derivatives are known to cause irritation to the skin, eyes, respiratory and gastrointestinal linings. The chemical is absorbed through the linings of the gut, lungs and skin and excreted from the body within a few hours to several days through the urine. 2,4,5, - T is not significantly concentrated or stored in the fatty tissues like the chlorinated hydrocarbon insecticides.

On the other hand, 2,3,7,8 - TCDD is one of the most toxic substances known to man (Rawls, 1979). An oral LD$_{50}$ of 0.6 micrograms/kg of body weight has been reported for the guinea pig, which is the most sensitive
animal tested in the laboratory (C.A.S.T., 1978; Rawls, 1979). Experiments with primates, such as the Rhesus monkey, indicate a much higher lethal oral dosage of around 70 micrograms/kg of body weight.

The mechanism of action for 2,3,7,8-TCDD toxicity has never been completely established. The effects of the chemical are highly variable from one species of animal to the other, with some animals being able to tolerate up to 1000 times as much 2,3,7,8-TCDD as other species. The oncogenic effects of the contaminant have been demonstrated with rats using several different dosage levels (Rawls, 1979). In an incident involving humans, where 2,3,7,8-TCDD contaminated 2,4,5-T was used by the U.S. Air Force in Vietnam during the early 1960’s, the incidence of liver cancer was documented to increase. This study had little data to significantly base its hypothesis and then it did not rule out other sources which might be linked to the increase in cancer incidence. Another incident in Italy in 1976 involved the explosion of a chemical reactor that contaminated 494 acres of towns and farmland around the plant, but there have been no abnormal reports of cancer or benign tumors linked to the incident.

The distribution of 2,3,7,8-TCDD in the tissues is another variable factor differing from one species of animal to another. In rodents (rats, mice, and rabbits) the target organ is the liver, while in primates (monkeys and man) the skin, muscle and the adipose tissue are the first to show toxic effects.

Of major concern to humans is the teratogenic effects suspected to be caused by 2,3,7,8-TCDD. In test animals birth defects have been observed (in some strains of rats and mice) at dosage levels as low as 0.01 micrograms/kg of body weight. In humans there have been no proven cases of birth defects caused by 2,4,5-T or its contaminant 2,3,7,8-TCDD, but there have been many allegations that the contaminant in 2,4,5-T causes birth defects and spontaneous miscarriages. The evidence from the Seveso, Italy incident has indicated that these changes are not to be believed thus far. The data from there indicates that of the 623 pregnant women contaminated with 2,3,7,8-TCDD, there was not a significant amount of birth defects or spontaneous miscarriages varying from the normal occurrence in that part of Italy any other year before or after the event.

Other symptoms of intoxication by 2,3,7,8-TCDD include chloracne, liver damage, hemorrhage and the inability of the body to fight off disease organisms. Of these symptoms chloracne, a black head type skin irritation, has been the first to be observed in humans around two to four days after exposure. At Seveso, Italy only a small number of children were observed with these symptoms.

Although the chlorophenoxy herbicides, which include 2,4,5-T, have been around since the early 1940’s, it was not until the Vietnam War that a major controversy arose in the United States over its use. The U.S. Air Force used a mixture of 2,4, dichlorophenoxyacetic acid (2,4-D) and
2,4,5-T to defoliate the jungle battlegrounds to protect the American soldiers fighting in South Vietnam. This chemical mixture was called "Agent Orange" giving the public the suggestion that it might be some secret biological weapon rather than a herbicide. This unethical hint of the use of biological warfare along with rumors coming from the indigenous jungle population of birth defects, skin irritation and numerous other symptoms turned the public pressure against the use of the herbicide.

The chemical was still being sold to the armed forces in 1968 with the largest amount, approximately 25,000 tons being spread over Vietnamese territory from 1962 to 1965. When the information about 2,3,7,8-TCDD was publicized by the press and environmentalists without regard for scientific proof, public pressure started a political movement against the herbicide. This campaign moved back to the United States—when the fact was made known that this same herbicide was being used on cropland, rangeland, forests, and various other areas here.

Several incidents, not relating to 2,4,5-T directly, helped turn public pressure against the herbicide. In 1971, 2,3,7,8-TCDD contaminated waste oil killed 63 horses and made several people ill after the oil was used to keep down the dust in the stables of a horse arena. The concentration of the contaminant was estimated to be between 0.5 to 5 ppm.

On July 10, 1976 an exothermic-type explosion occurred in a reactor in a plant producing trichlorophenol as a step for subsequent production of the antibacterial agent, hexachlorophene. The incident resulted in the release of the contaminant T into the local environment of Seveso, Italy, a suburb of Milan. Chemical adversaries and advocates have made this an international case for controversy. T in an amount equal to the total released in the entire continental United States in one year was released into the small community of approximately 750 square acres. Although local authorities were notified within two days, evacuation of families did not begin until 17 days later and was completed about three and a half weeks after the explosion occurred. Five months elapsed before any records of T levels were released. Three Zones A, B, and R downwind from the plant were monitored and the levels for the Zones under surveillance were 230 mcg/m² in Zone A; 3.0 mcg/m² in Zone B; and 0–0.5 mcg/m² in Zone R.

The population of Zone A (736) was fully evacuated. Zone B had a population of 4700, and women in their first trimester of pregnancy and children were advised to move out of the area. The remaining Zone labeled R had a population of 31,800 people and was considered a surveillance area since their contamination was believed to be minimal.

The population was monitored through a series of parameters:

1. Chloracne (skin lesions) was the most striking clinical feature in all exposed individuals, with 175 cases confirmed based upon clinical examination. It was severe enough to persist for two or more years. From examinations of the more than 32,000 population there were about 600 cases of possible chloracne and children were particularly susceptible; however, the lesions healed rapidly following removal.
from the TCDD and after one year there was only a total incidence of 0.4%.

2. Neurological Effects: No acute lesions of peripheral or central nervous system were described, but a gradual development of a peripheral neuritis, subclinical in terms of symptoms but definite in terms of the neuro-physiological examination was recorded from the heavily contaminated zone only, and no correlation could be demonstrated between the occurrence of chloracne and the neurological findings. None of the children with chloracne had any impairment of nervous system functions. Eight of 156 plant employees had some motor conduction impairment similar to that noted in the general population.

3. Organ Involvement: Examinations revealed a transient hepatomegaly in about 8–10% of the people examined, and a transient increase in serum enzymes. No damage was detected in the hematopoietic or urinary systems. Plant workers had a lower incidence of abnormal liver function studies than the exposed population.

Agricultural chemicals have become a fact of life for the universe and amid all the concerns and unresolved controversy over their use, most people would not be satisfied to discontinue using them.

Studies by a major producer of chlorophenoxy herbicides indicate that the chlorinated dibenzo-p-dioxins, including 2,3,7,8-TCDD, can be produced by any kind of combustion ranging from automobile exhaust to incinerator fires. Hopefully the continuing work of the scientific community will find a solution to this complex problem.
# Long Term Studies of TCDD Accidents

<table>
<thead>
<tr>
<th>Town and Country</th>
<th>Year</th>
<th>Number of Exposed Persons</th>
<th>Clinical Follow-Up</th>
<th>Preliminary Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitro, WV, USA</td>
<td>1949</td>
<td>228</td>
<td>30 years</td>
<td>No significant effect to date</td>
</tr>
<tr>
<td>Ludwigshafen/Rhein, Germany</td>
<td>1953</td>
<td>75</td>
<td>Mortality study–24 years on all persons</td>
<td>6 cancer deaths to date (3 of stomach)</td>
</tr>
<tr>
<td>Amsterdam, Holland,</td>
<td>1963</td>
<td>106</td>
<td>93 persons followed</td>
<td>8 deaths with 5 or 6 from cardiovascular disease</td>
</tr>
<tr>
<td>Bolsover, Derbyshire, UK</td>
<td>1968</td>
<td>90</td>
<td>50% still unemployed</td>
<td>1 death from myocardial infarction</td>
</tr>
<tr>
<td>Seveso, Italy</td>
<td>1976</td>
<td>(?40,000</td>
<td>80–90%</td>
<td>Chloracne, possible transient hepatomegaly</td>
</tr>
<tr>
<td>Czechoslovakia</td>
<td>1965–1969</td>
<td>80</td>
<td>55 persons</td>
<td>5 deaths (2 CA, 1 CV, 1 cirrhosis). Possible high frequency of hyperlipidemia and hypertension</td>
</tr>
</tbody>
</table>
AROMATIC-DEPENDENT SALMONELLA AS LIVE VACCINES IN CALVES

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ABSTRACT

Salmonellosis continues to be a major public health problem and to cause economic losses in confinement reared cattle. S. typhimurium and S. dublin are the two most consistently isolated serotypes. S. dublin is host adapted to cattle and appears to be spreading in the U.S.

Salmonella typhimurium SL 1479 (01,4,12) and S. dublin SL1438 (09,12), genetically altered to become nonreverting, nonvirulent aromatic-dependent (aro⁻), strains were used as modified live vaccines in normal 2 and 3 week old calves. Twenty-two calves were vaccinated intramuscularly with 10⁹ aro⁻ S. typhimurium SL1479 or S. dublin SL1438 at 2 weeks and again at 3 weeks of age without serious adverse effects. Three calves were vaccinated orally with 10¹¹ aro⁻ S. typhimurium SL1479, also at 2 and 3 weeks of age, without adverse effects. At 5 weeks of age the 25 vaccinated calves and 21 nonvaccinated control calves were orally challenge exposed to 10¹¹ virulent S. typhimurium or S. dublin. Whereas 18 of 21 nonvaccinated calves died, only 2 of 25 vaccinated calves died (P<.001). Protection against death was conferred by vaccination for both homologous and heterologous serotypes.

INTRODUCTION

Salmonellosis is most often a problem under conditions of intensive animal agriculture where crowding exists and artificial diets for calves are often utilized. Salmonellosis is one of the few serious diseases which is actually increasing in incidence in the world today (1). In a recent study of the causes of neonatal calf diseases, salmonellosis was the leading cause (34%) in dairy calves (2). In this same study, S. dublin made up 40% of the Salmonella isolates. Salmonella typhimurium and S. dublin are the two serotypes most commonly associated with disease in cattle, although a number of other serotypes are pathogenic for cattle. S. dublin is a cattle host adapted serotype which for years was limited in the U.S. to Western states. S. dublin has been spreading in the U.S. and by 1980 had been isolated from 23 states,³ and by 1983 had been isolated from additional states. The efficacy of killed Salmonella bacterins has been controversial (4,5,6,7) and relatively avirulent rough S. dublin mutants have been used successfully as vaccines (8,9,10).
S. typhimurium with complete nonreverting defects in gene aroA have been shown to be nonvirulent and to elicit excellent protection against virulent challenge (11) in strains of mice not protected by repeated injection of killed S. typhimurium and (12). Calves vaccinated with a commercial vaccine containing killed S. typhimurium and S. dublin were not protected against oral challenge with virulent S. typhimurium (13). The purpose of this study was to evaluate the safety and efficacy of nonvirulent, nonreverting aromatic-dependent (aro^-) Salmonella as calf vaccines.

MATERIALS AND METHODS

Animals. Normal colostrum fed Holstein or Holstein-Angus cross calves were obtained from a dairy from which Salmonella had never been isolated. Only calves with normal serum globulin levels, normal complete blood count and negative fecal cultures for Salmonella were used. Calves to be vaccinated were brought to the maximum isolation facilities at 2 weeks of age. Nonvaccinated control calves were housed at the dairy until 5 weeks of age, at which time they were brought to the maximum isolation facility and orally challenged. Calves were fed pasteurized whole milk and alfalfa hay.

Vaccination Schedules and Dose. Twelve calves were vaccinated twice intramuscularly (I.M.) with 1.5 x 10^9 aromatic-dependent (aro^-) S. typhimurium strain SL1479. Three calves were vaccinated twice orally with 1.5 x 10^9 aro^- S. typhimurium SL1479. Ten calves were vaccinated twice with 10^6 aro^- S. dublin strain SL1438. Calves were vaccinated first at 2 weeks of age and again at 3 weeks of age, then challenged at 5 weeks of age.

Vaccine Strains: Using a transposon-deletion technique involving gene aroA, virulent S. typhimurium UCD 108-11 was modified to become nonreverting, nonvirulent, aromatic-dependent (aro^-) live vaccine strain SL1479 (11). This same technique was applied to virulent S. dublin SL4454 to produce aro^- S. dublin SL1438.

These strains were maintained on nutrient agar slants, grown without shaking for 18 hrs. in trypticase soy broth, and used fresh as vaccine. A dose of 1.0 to 1.5 x 10^11 organisms were used for oral vaccination of three calves (group 7, challenge schedules).

Challenge Strains and Dose. Two virulent S. typhimurium strains, UCD 108-11 and SL1323, and one virulent S. dublin, SL1367, were maintained on nutrient agar slants. Trypticase soy broth was inoculated, incubated without shaking for 18 hours, and used fresh at a dose of 1.0 to 1.5 x 10^11 viable organisms delivered by oral drenching.

Challenge Schedules. For purposes of challenge, calves were divided into the following groups and orally given 1.5 x 10^11 virulent Salmonella 2 weeks following second vaccination.

Group 1: Twelve nonvaccinated controls challenged with strain UCD 108-11 S. typhimurium.

Group 2: Four nonvaccinated controls challenged with strain SL1323 S. typhimurium.
Group 3: Five nonvaccinated controls challenged with strain SL1367 S. dublin.


Group 5: Four \textit{aro}^- S. typhimurium SL1479 I.M. vaccinated calves challenged with SL1323 S. typhimurium.


RESULTS

No serious adverse reactions to vaccination occurred.

Following challenge 18 of 21 nonvaccinated calves died, whereas only 2 of 25 vaccinated calves died. Calves in groups 1, 2 and 3 experienced death losses of 11 of 12, 3 of 4, and 4 of 5 respectively following challenge (Table 1). In contrast, 0 of 3 group 4 calves died, 1 of 4 group 5 calves died, 1 of 5 group 6 calves died, 0 of 3 group 7 calves died, 0 of 5 group 8 calves died, and 0 of 5 group 9 calves died following challenge. All vaccinated groups are significantly different from the corresponding nonvaccinated challenge group (P< .05) with regard to survival following challenge.

DISCUSSION

Vaccination of calves at 2 and 3 weeks of age with genetically altered aromatic-dependent (\textit{aro}^-) S. typhimurium SL1479 or \textit{aro}^- S. dublin SL1438 proved safe and effective at preventing mortality following oral challenge. Intramuscular vaccination with \textit{aro}^- S. typhimurium SL1479 proved effective against two different virulent challenge strains of S. typhimurium, UCD 108-11 and SL1323, as well as against challenge with virulent S. dublin SL1367. The cross serotype protection was somewhat of a surprise, and may reflect the fact that these two serotypes share an O antigen (S. typhimurium SL1479 O antigenic structure 01,4,12; S. dublin SL1367 O antigenic structure 09,12). Opsonins capable of acting on both serotypes are probably produced against this common antigen.

Nonspecific cellular immune mechanisms responsible for enhanced bactericidal mechanisms also appear to play a role in protection (Johnson, E.H. personal communication). These nonspecific mechanisms may be rather short-lived in duration, although we did not examine this aspect past the challenge period.

It was interesting to note that all three calves orally vaccinated twice with \textit{aro}^- S. typhimurium SL1479 survived. We expected that the \textit{aro}^-
strains, which were derived from virulent parent strains, would maintain the ability to survive in the gut and host tissues and therefore be highly antigenic, yet be unable to multiply. This was apparently the case. \textit{Aro}^- strains require the aromatic metabolites para-aminobenzoate (for making folate) and dihydroxybenzoate (for making enterochelin), which are not available in mammalian tissues. This genetic defect renders the organism unable to multiply and it therefore becomes nonvirulent without losing other (unknown) factors responsible for stimulating a satisfactory immune response.

All 10 calves vaccinated parenterally with \textit{aro}^- \textit{S. dublin} SL1438 survived challenge, 5 with \textit{S. dublin} and 5 with \textit{S. typhimurium}. The cross serotype protection seems to work in both directions, presumably for the reasons stated earlier.

Using the same oral challenge dose and organism (\textit{S. typhimurium} UCD 108-11), a previous study had demonstrated that vaccination with a commercial bacterin containing \textit{S. typhimurium} and \textit{S. dublin} did not protect calves against death (13) Robertsson and colleagues (14) have recently confirmed our findings. Working with a different \textit{S. typhimurium} challenge strain in Sweden, they demonstrated some protection from killed bacterins at the relatively small challenge dose, which broke down against a large challenge dose. In contrast, modified live \textit{aro}^- \textit{S. typhimurium} SL1479 protected at the large challenge dose (14).

We now believe that both humoral and cellular immune mechanisms play partnership roles in protecting calves from Salmonella challenge. The ability of living organisms to stimulate cellular immune mechanisms (many of which are nonspecific) appears to be one of the reasons that \textit{aro}^- Salmonella protect calves against challenge more solidly than do killed Salmonella bacterins (14).

**ACKNOWLEDGEMENTS**

Supported in part by the California Milk Advisory Board, Western Regional Research Funds, Smith Kline Animal Health Products and Grant No. A1-07168 from the National Institute of Allergy and Infectious Disease (Stocker).

The authors thank Tina Steward for technical assistance.
Table 1. Number of calves dead following challenge. Calves were vaccinated at 2 weeks and again at 3 weeks of age, and then orally challenged with $1 \times 10^{11}$ organisms at 5 weeks of age.

<table>
<thead>
<tr>
<th>Group</th>
<th>Vaccination</th>
<th>Oral Challenge</th>
<th>Number calves dead/total calves</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>None</td>
<td><em>S. typhimurium</em> UCD 108-11</td>
<td>11/12</td>
</tr>
<tr>
<td>2</td>
<td>None</td>
<td><em>S. typhimurium</em> SL 1323</td>
<td>3/4</td>
</tr>
<tr>
<td>3</td>
<td>None</td>
<td><em>S. dublin</em> SL 1367</td>
<td>4/5</td>
</tr>
<tr>
<td>4</td>
<td>I.M. aro-</td>
<td><em>S. typhimurium</em> UCD 108-11</td>
<td>0/3</td>
</tr>
<tr>
<td></td>
<td><em>S. typhimurium</em> SL 1479</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I.M. aro-</td>
<td><em>S. typhimurium</em> SL 1323</td>
<td>1/4</td>
</tr>
<tr>
<td></td>
<td><em>S. typhimurium</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I.M. aro-</td>
<td><em>S. dublin</em> SL 1367</td>
<td>1/5</td>
</tr>
<tr>
<td></td>
<td><em>S. typhimurium</em> SL 1479</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Oral aro-</td>
<td><em>S. typhimurium</em> UCD 108-11</td>
<td>0/3</td>
</tr>
<tr>
<td></td>
<td><em>S. typhimurium</em> SL 1479</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>I.M. aro-</td>
<td><em>S. dublin</em> SL 1367</td>
<td>0/5</td>
</tr>
<tr>
<td></td>
<td><em>S. dublin</em> SL 1438</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>I.M. aro-</td>
<td><em>S. typhimurium</em> UCD 108-11</td>
<td>0/5</td>
</tr>
<tr>
<td></td>
<td><em>S. dublin</em> SL 1438</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All vaccinated groups are significantly different from corresponding nonvaccinated challenge groups ($P<0.05$).
REFERENCES


SUMMARY

Serotyping of salmonella and Arizona cultures from animal disease cases and epidemiologically related sources is reported for October 1, 1981, through September 30, 1982 (FY 1982). A total of 5389 cultures were serotyped. The most frequently identified salmonella serotypes were Salmonella typhimurium, S. cholerasuis var. Kunzendorf, S. typhimurium, var. Copenhagen, S. anatum and S. heidelberg. The most frequently identified Arizona serotype was 7a,7b:1,7,8. The most frequent sources of cultures in order of frequency were cattle, swine, turkeys, and chickens.

INTRODUCTION

Data for this report were accumulated at the National Veterinary Services Laboratories, Animal and Plant Health Inspection Services, USDA, Ames, Iowa. Other laboratories contributing serotyping information were Paige Laboratory, University of Massachusetts, Amherst, Massachusetts, and the Animal Health Laboratories of the Wisconsin Department of Agriculture, Madison and Barron, Wisconsin.

The data, except for serotyping results, were provided by the many laboratories requesting serotyping services. Most of these laboratories appreciate the importance of accurate data and made a concentrated effort to provide quality input. Also, the reports were screened for obvious errors. However, it was not possible to verify each entry and the quality of the total report is a reflection of the cooperative spirit of these laboratories.

The purpose of this report is to make the data available to epidemiologists and others who have a need for it. The data are presented in tables as in previous reports in order that comparison can be easily made.

DISCUSSION

Cultures for serotyping were received from 44 states, the District of Columbia, and Puerto Rico (Tables 1 and 3). This is less by 4 states and Guam than for FY 81.

The total number of cultures serotyped was 5389. This was an increase of 465 from the previous year and an increase of 1232 from the average for the previous 5 years.
Serotypes identified came to a total of 121 (Tables 2 and 4). The 10 most common salmonella serotypes which accounted for 67% of that total are given in Table 10. Two different serotypes from last year, S. muenchen and S. san diego, appear among these 10 most common. The appearance of S. muenchen in this table resulted largely from a great increase of isolations in Indiana from cattle. S. muenchen has never before been identified so commonly in these reports. S. san diego has been among the top 10 as recently as FY 1978. Its close association with turkeys continues.

Salmonella hadar was reported from North Carolina for the first time. However, the total identifications for this serotype were reduced.
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*Number of times the serotype was identified

**Rank beginning with the most common
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TOTALS: 20 51 777 70 25 10 14 187 80 10 444 456 186 204 46 205 338 4 137 12 207 51 9 49 177 15 55 1 100 47 15 142 108 75 27 14

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- FROM AZ = 2 TYPHOMINUM
- FROM CO = 1 TYPHOMINUM
- FROM DC = 1 TYPHOMINUM
- FROM DE = 1 TYPHOMINUM
- FROM FL = 1 TYPHOMINUM
- FROM GA = 1 TYPHOMINUM
- FROM HI = 1 TYPHOMINUM, 1 TYPHOMINUM (COPENHAGEN)
- FROM ID = 1 TYPHOMINUM (COPENHAGEN)
- FROM IA = 1 TYPHOMINUM
- FROM IN = 1 TYPHOMINUM, 1 JAVANA, 1 TYPHOMINUM
- FROM IA = 1 TYPHOMINUM

(c) VIA N. EINZENBERG

(c) VIA N. EINZENBERG
## Table 2. Distribution of Salmonella Serotypes by Source - FY82

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**Table 5. Turkey—Most Frequently Identified Serotypes in FY82**
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<tr>
<th>Serotype</th>
<th>Identified Times</th>
<th>Identified Size</th>
<th>AVE. Flock Size</th>
<th>PERCENT MORTALITY HIGHEST</th>
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<td>404-TEVEDO</td>
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<td>10</td>
<td>1,24210</td>
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<td>TYPHIMURUM (COPENHAGEN)</td>
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<td>SEROTYP</td>
<td>TIMES IDENTIFIED</td>
<td>AVE. HERD SIZE</td>
<td>PERCENT MORTALITY HIGHEST</td>
<td>PERCENT MORTALITY AVERAGE</td>
<td></td>
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<td>----------------</td>
<td>---------------------------</td>
<td>--------------------------</td>
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<tr>
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<td>TYPHIMURIUM (COPENHAGEN)</td>
<td>233</td>
<td>78</td>
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<tr>
<td>DUBLIN</td>
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<td>MUNCHEN</td>
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<td>SAINT PAUL</td>
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<tr>
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<td>150</td>
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<td>6.7</td>
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<td>SEROTYPE</td>
<td>TIMES IDENTIFIED</td>
<td>AVE. HERD SIZE</td>
<td>PERCENT HIGHEST</td>
<td>MORBIDITY AVERAGE</td>
<td>PERCENT HIGHEST</td>
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<td>----------------</td>
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<tr>
<td>CHOLERASUIS (KUNZENDORF)</td>
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<td>TYPHIMURIUM (COPENHAGEN)</td>
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<td>329</td>
<td>100</td>
<td>18.6</td>
<td>35</td>
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<tr>
<td>AGONA</td>
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<td>ALL OTHERS</td>
<td>112</td>
<td>256</td>
<td>100</td>
<td>11.7</td>
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</table>
### Table 9. HUS SE—MOST FREQUENTLY IDENTIFIED SEROTYPES IN FY82

<table>
<thead>
<tr>
<th>SEROTYPE</th>
<th>TIMES IDENTIFIED</th>
<th>AVE. HERD SIZE</th>
<th>PERCENT HIGHEST MORBIDITY</th>
<th>AVERAGE</th>
<th>PERCENT HIGHEST MORTALITY</th>
<th>AVERAGE</th>
</tr>
</thead>
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<tr>
<td>TYPHIMURIUM</td>
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<tr>
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<td>4.5</td>
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<td>3.5</td>
</tr>
<tr>
<td>ANATUM</td>
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</tr>
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<td>100</td>
<td>100.0</td>
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<td>9.1</td>
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<tr>
<td>MUNICHEN</td>
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<td>14</td>
<td>100</td>
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<td>3.2</td>
</tr>
<tr>
<td>MANHATTAN</td>
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<td>9.6</td>
<td>100</td>
<td>4.1</td>
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</table>
On November 12, 1975, the Secretary of Agriculture established the U.S. Salmonella Advisory Committee. The Committee was composed of representatives from academia, the meat and poultry industry, the feed industry, state and Federal regulatory officials and consumer interest groups. The Committee members quickly aligned themselves into six working groups; feed and feed ingredients; breeders and hatcheries; production; processing; consumer education; and research. These working groups met in various places around the country bringing in resource people to help in formulating recommendations that would be considered by the full Committee.

The Committee was directed to study measures to reduce the incidence of salmonella organisms in live birds and animals and limit the spread of salmonella contamination during slaughtering and further processing operations. The committee was also given the responsibility of recommending and soliciting the cooperation of industries in implementing any measures decided. Further, the Committee was instructed to recommend regulatory requirements needed to apply critical control procedures, and to consider means of disseminating information on preventive practices to all segments of industry and to consumers.

The Advisory Committee, after holding several plenary sessions in 1976–77, published a report in January 1978 that listed more than 40 recommendations for implementation by government and industry. These recommendations were comprised of three main types: (1) measures to be taken to assess the incidence of salmonella under present practices; (2) procedures to be implemented by using existing technology; and (3) areas for future research. The recommendations encompassed the entire range of meat and poultry food production from the farm to the dinner table. Changes were suggested in such areas as livestock and poultry production and management, transportation, sanitation and processing, inspection procedures, distribution and marketing, and consumer education.

Since 1978 the Department has continued its own efforts in salmonella control and reduction and has consulted frequently with members of industry, professional organizations, and academic institutions. Forums such as the Salmonella Committee of the U.S. Animal Health Association and the annual program planning and budget workshop of the Department's Agricultural Research Service and Food Safety and Inspection Service have occasioned valuable exchanges of information. The Association’s Salmonella Committee has stressed for some time the importance of fully implementing the Committee's feed and feed ingredient

*Presented by Dr. W. H. Dubbert. A full report addressing the USDA Salmonella Advisory Committee Recommendations is available from the Information Division, FSIS, USDA.
recommendation. The Committee considers the issue most important if substantial gains are to be made in reducing the incidence of Salmonellosis in meat producing animals and poultry.

The Department's Agricultural Research Service (ARS) has recently completed a 3-year study of the bacteriology of livestock and poultry feed. Each fiscal year (November 1 to October 30) since 1978, ARS has monitored the occurrence of salmonella and arizona in feed and feed ingredients. The feed ingredients that were sampled both fish solubles, and bone and meat meal. In 1980 673 feed samples taken were 16% positive for salmonella in fish solubles and 63% positive for salmonella in meat and bone meal samples.

The results of this study show declining rates of occurrence of salmonella in both types of ingredients. From 1980 to 1982, for example, salmonella in meat and bone meal samples declined from about 63 percent to around 16 percent.

In addition to this 3-year sampling project, ARS has conducted specialized studies aimed at reducing salmonella in feed through improved processing procedures. In a recent investigation, for example, salmonella were isolated routinely from poultry mash feed samples, but not from pelleted samples. Enterobacteriaceae were found in pelleted food, however, and this discovery was taken as an indication that salmonella could survive pelleting.

Following the Advisory Committee's report, the FDA published a new brochure containing guidelines for feed manufacturers. For a number of years, the Agricultural Research Service has distributed bulletins on sanitation guidelines for salmonella control in rendering plants and feed mills.

The Advisory Committee recommended research to identify antagonists, such as Formalin for salmonella that could be used in feeds. However, since the report was published serious questions have been raised concerning the possible harmful effects of formaldehyde on man. The Department is, however, exploring other means of reducing salmonella numbers, including competitive inhibition, or competitive exclusion. When this technique is used, microflora hostile to salmonella are grown in the same environment and eliminate the salmonellae by preventing their attachment to intestinal villi.

The Department recognizes that unsatisfactory carriers represent a continuing threat to the sanitation of feeds and feed ingredients. Improvements in this area must ultimately depend on progress in the transportation industry. Even so, the Department has supported research aimed at reducing the contamination during transport.

For example, because contaminated crates appeared to be a major source of the spread of salmonellae, funds were provided to the Pennsylvania State University in Fiscal Year 1980 to investigate the amount of contamination in crates and to measure the effectiveness of cleaning and disinfecting crates at processing plants.
The Department has recently supported epidemiological studies of turkeys and broilers at the Universities of Georgia and Minnesota. These projects were designed in three phases or segments. The first was to evaluate the feasibility of maintaining salmonella-free breeding flocks over the extended period necessary for producing the required breeding and commercial products. The next phase was to evaluate the feasibility of maintaining salmonella-free poultry from hatching to the processing plant. The third phase was to evaluate the feasibility of producing salmonella-free hatching eggs and baby poultry from a contaminated breeding flock; in other words, to prevent the egg transmission of salmonella. These projects were designed for a 3-year period. The epidemiological studies officially terminated September 30, 1982. As a result of our studies of turkeys, we have been able to determine that if salmonella-free breeding replacement poults are delivered to a salmonella-free facility, the turkeys can be kept salmonella free.

In the studies of broiler chickens, we didn't fare as well. All flocks became contaminated with a salmonella early in the breeding season. Because a salmonella-free broiler breeding flock could not be located, the second phase could not be studied in the chicken broiler industry. Attempts to produce salmonella-free flocks from hatching eggs obtained from a contaminated breeding flock succeeded in only two cases. On the basis of the broiler studies, we were able to determine that it is not economically feasible to produce broilers free of salmonella using present-day facilities under good management.

The Advisory Committee called for benchmark studies on feed ingredients, live animals and poultry, and fresh meat and poultry products leaving the plant. While benchmarks are still lacking for salmonella in feed and livestock, the Department has recently published survey results on the incidence of salmonella in young whole chicken carcasses and in fresh pork sausage. The survey involving chicken carcasses compared 1979 salmonella levels with those found in 1967. The survey on the incidence of salmonellae in pork sausage compared 1979 with 1969 levels.

In the chicken study, carcasses from 15 federally-inspected chicken eviscerating plants were analyzed using a carcass washing technique for determining the presence of salmonellae. In the 1967 study, salmonellae were isolated from 171 of 597 (28.6 percent) whole-chicken tetrathionate broth rinsings analyzed. In the 1979 study, 222 of 601 (36.9 percent) of similarly analyzed chicken samples were positive for salmonellae. Percentile positive findings from individual plants range from 7.5 to 73.7 percent in 1967 and from 2.5 to 87.5 percent in 1979.

The analysis of fresh pork sausage involved retail-size samples collected from 40 federally-inspected plants and representing different days of production. The results obtained during the 1979 survey were compared to results obtained in a similar 1969 survey. Salmonellae were isolated from 162 of the 566 (28.6 percent) samples analyzed in 1969. For the samples analyzed in 1979, 74 of 603 samples (12.4 percent) were positive for
salmonellae. The reduction of 16.2 percent over 1969 indicates a reduction in the incidence of salmonellae in this product for the firms tested.

The Committee strongly recommended that Congress appropriate funds for a cadre of veterinary salmonella epidemiologists. These specialists from Veterinary Services (USDA, APHIS) would work with state veterinarians on field epidemiological sampling and investigations. Unfortunately, no large appropriations for this work have been made. USDA and the states, however, do maintain veterinary epidemiological staffs that monitor salmonellosis outbreaks.

For example, USDA's National Veterinary Services Laboratory (NVSL) compiles an annual summary of data on salmonella and arizona serotypes from animals and related sources. Also, the Animal and Plant Health Inspection Service has funded epidemiological studies of salmonella in turkeys at the University of Minnesota, in broiler chickens at the University of Georgia, and of wine salmonellosis at Purdue University. In addition, an allocation was made to NVSL for laboratory support and serotyping services for these and other epidemiological projects. In spite of these efforts, we acknowledge that there is still a need for improvement of investigation and monitoring, in correlation between serotyping and cases of disease, and in the consistency of overall surveillance. Although there has been nationwide coordination of information on salmonella and salmonellosis, the overall surveillance is inconsistent.

Since 1981, the control of salmonella in domestic animals has been established as the number one research priority in FSIS. This was in response to the Committee's desire to triple the studying for salmonella research projects. The top priority this year will be given to feed research issues, such as the effect of fat levels steam pressure, and die size for pelleting; search for antibacterial agents and processing temperatures. In the current fiscal year, additional research will be undertaken in several areas, including meat production and slaughtering methodology, poultry chilling methods, and the education of processors and consumers.

The Department has consistently stressed the importance of observing correct processing procedures and maintaining proper separation between raw and cooked poultry products on other key recommendations from the Committee. In the last few years the Department has also published explicit rules governing these procedures. Cooking requirements for cooked and roast beef involving time, temperature, and in some cases, relative humidity, were established in 1977 and 1978 following a number of outbreaks of salmonellosis.

Following implementation of the new cooking requirements, one outbreak of salmonellosis occurred in 1978 because of a deviation from the requirements. No further outbreaks occurred until 1981, when there were several. Recent surveys have also revealed the presence of salmonellae in cooked corned beef. Investigation has shown that the outbreaks of salmonellosis in 1981 occurred because the processors involved did not use one of the prescribed cooking time and temperature combinations, or failed to maintain good sanitary practices, or failed to maintain adequate sep-
aration of raw and cooked product. Cooked products were thus allowed to become recontaminated and adulterated.

In 1982, the Department published interim final rules clarifying the existing rules, strengthening the cooking requirements, and establishing new marking, handling, and storage requirements. The Department also published new information materials concerning the proper handling of cooked roast and corned beef products. In addition, the American Meat Institute has issued a new set of guidelines on good manufacturing practices for precooked, fresh, and cured cooked beef.

The Advisory Committee recommended a training program be designed for plant employees emphasizing the reasons for sanitary handling of meat and poultry products. In response, the Food Safety and Inspection Service is developing training materials on basic sanitation for employees of slaughtering and processing plants. Also, many companies have employee training programs that emphasize the importance of maintaining high standards of sanitation and proper food handling methods. FSIS reviews these programs whenever possible and offers advice and technical assistance to companies if improvements in the programs are called for. The Agency does not, however, have the authority to mandate that companies institute such training programs; the programs are voluntarily submitted for review.

The Department encourages the use of chlorine in red meat slaughtering plants during the final carcass wash and the chilling process. In preliminary studies conducted by the Food Safety and Inspection Service, there appears to be a direct relationship of chlorine usage and a reduction in salmonella. In another study not completed, chlorinated poultry carcasses reflect 10% fewer samples that were positive for salmonella.

To avoid potential concentrations of carcinogens, the Food and Drug Administration will not permit the chlorination of sprays applied to cuts of meat smaller than a quarter-carcass. Carcass washing studies by the Agricultural Research Service and the Food Safety and Inspection Service will address concerns about the effect of chlorinated sprays on bacteriological levels of red meat carcasses as well as shrinkage and other matters. Alternatives to chlorine are also being considered for use in carcass-spraying solutions. For example, officials of New Zealand and Australia have requested that the Food and Drug Administration approve one percent propionic and three percent acetic acid as being generally recognized as safe for use in carcass sprays. Acetic acid solutions are known to have the effect of killing or retarding the growth of salmonellae.

The Advisory Committee recommended that water should be chlorinated when chilling or spraying meat or poultry carcasses. USDA encourages, but does not require, the use of chlorination at various stages of slaughtering and further processing. The Department is studying the value of total inplant applications of chlorine, including the use of chlorine in the final wash and chilling of meat and poultry carcasses. Chlorine is widely-used in the meat and poultry industry, and chlorine levels applied
in different plants vary widely (from as little as 1 ppm as a residual in water to 200 ppm in the cleaning of equipment in beef slaughterhouses).

Two phenomena that are observed when chlorine is used have provoked concern. One of these involves the measurement of residual chlorine—the amount of chlorine remaining in a solution at the end of the purification or sanitation process. During the process, most of the chlorine initially placed in a system reacts chemically with substances on the meat or equipment being cleaned to form chlorinated hydrocarbons. When these compounds are formed, the chlorine is neutralized as a bactericide. For this reason, serious questions have been raised about the effectiveness of chlorine in reducing bacterial numbers in meat and poultry plants. Precise knowledge of the amount of chlorine remaining in a solution would permit some evaluation of the success of chlorination in reducing the bacterial count.

The second matter of concern is that many of the chlorinated hydrocarbons formed during chlorination are carcinogenic to some degree. Further research is needed to determine the amounts of chlorinated hydrocarbons or other halogenic compounds that might pose health hazards. In addition, alternatives to chlorination are being considered.

These considerations are important in current research projects on chlorination. For example, FSIS and ARS have been cooperating on studies to determine the effectiveness of chlorine as a poultry equipment sanitizer. Work on this project is being conducted at USDA research facilities in Athens, Georgia. Among the phenomena being studied is the tendency for chlorine to combine with organic substances to form a film-like coating on equipment. The coating can be very easily washed off the equipment with running water. For this reason, even if chlorine is shown to be unacceptable as a germicide, it may be a very good choice as a sanitizing agent.

The Committee recommended that the Department support and emphasize the importance of the reduction of salmonella in all parts of the food chain and that it should increase the use of mass media for dissemination of food safety information to consumers.

The Department distributes hundreds of thousands of food safety publications to consumers and industry. In addition, the Department issued press releases and feature articles on the occurrence and prevention of contamination in meat and poultry products. The Department advises industry on correct production and processing procedures through regular issuances of its inspection program.

For several years, the Department has distributed a factsheet advising food service operators and employees on correct handling procedures for meat and poultry products. The factsheet has recently been updated in the wake of salmonella contaminations of delicatessen products in the northeastern United States. The new information stresses the importance of
maintaining proper cooking and storage temperatures and strict separation of raw and cooked products.

The Department has always recognized the importance of continuing public information efforts in this area because the consumer population is constantly changing. Both before and after the Advisory Committee met, the Department prepared numerous radio and television public service announcements to alert consumers about the importance of proper food handling procedures. Certain techniques, such as the use of animation, have been chosen especially for the purpose of presenting single concepts in an effective, memorable way.

The Department is eager to share its research findings and to consider suggestions for the improvement of its regulatory programs. Interagency projects will be carried out, and Department scientists and officials will continue to work with such bodies as the U.S. Animal Health Association, the American Veterinary Medical Association, the American Association of Veterinary Laboratory Diagnosticians, and the American Association of Avian Pathologists. USDA will also continue, as it has in the past, to exchange information with foreign groups. In 1984, for example, an international symposium will be convened to review the state of scientific research and technological progress in controlling salmonella. The Department is, therefore, committed to fulfilling the objectives of the 1978 Advisory Committee while expanding the scope of its anti-salmonella efforts.

In future conferences and workshops, such as the 1984 symposium, Government and industry scientists will have the opportunity of exchanging views on the most fruitful new approaches to be taken toward the salmonella problem. The work that has been accomplished in response to the Advisory Committee recommendations will then form the basis for further initiatives in this field.
REPORT OF THE COMMITTEE ON SALMONELLA

Chairman: B. S. Pomeroy, Minnesota
Vice Chairman: G. H. Snoeyenbos, Massachusetts

C. W. Beard, GA; Fred Bisplinghoff, IN; B. O. Blackburn, IA; M. S. Cover, MO; M. L. Crandall, MD; W. H. Dubbert, VA; R. D. Glock, AZ; F. A. Hayes, GA; R. L. Hogue, IN; W. L. Kadel, KY; D. D. King, MD; E. T. Mallinson, MD; C. S. McCain, OK; E. L. Menning, VA; E. V. Morse, IN; J. P. Newman, MI; Robert Nicholas, CA; I. L. Peterson, MD; R. A. Robinson, MN; Raymond Schar, MD; Keith Van Steenbergh, MD; C. R. Weston, NH.

Ex Officio: Alan H. Bentley, Canada; W. B. Bixler, MD; W. E. Patterson, GA

The committee met at 1:30 p.m., Wednesday, October 19, 1983. Seventeen members and twenty guests attended.

Activities of the Committee since 1982 meeting were reviewed.

1. Letters were sent to State Veterinarians in 22 states encouraging them to take the necessary action to qualify their states for classification of U.S. Pullorum-Typhoid Clean State.

2. Members of the Committee participated in a meeting in Washington, D.C. on April 13 with USDA-APHIS-VS to summarize the current information on salmonellosis in livestock and poultry particularly in the production area so that a practical and informative approach can be taken toward the disease. Twelve members of the Committee were involved in the meeting.

3. Twelve members of the Committee have participated in planning meetings for an International Symposium on Salmonella which will be held in 1984.

The first item on the agenda of the meeting of the Committee at this meeting was a progress report of the Planning Committee for the International Symposium on Salmonella that will be held on July 19 & 20, 1984 at New Orleans, LA at the time of the AVMA meeting. The major purposes of the Symposium are to identify practical approaches to prevent or reduce infections in major food animal populations and contamination of food products derived from them. The effect of salmonella contamination of animal products on international trade will be assessed and need for standardization and harmonization of salmonella isolation methods will be considered. Although the program has not been completed, commitments for speakers outside the U.S. have been already secured from Australia, Japan, Israel, France, Holland, England, Finland and Canada. The major sponsoring organization is the American Association of Avian Pathologists which has provided major financial support. Major support has been committed from federal agencies including USDA-APHIS, FSIS, ARS, FAS AND U.S. Department of Health and Human Services, Bureau of Veterinary Medicine, FDA and Centers for Disease Control, U.S. Public

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Health Services. Significant support has also been provided to date by AAVLD, NAFV, AAEP as well as from a number of allied industries. Dr. Glenn H. Snoeyenbos is Chairman of the International Planning Committee and 12 members of USAHA Committee on Salmonella are on the Planning Committee.

Three general reports were presented to the Committee.

1. Dr. B. O. Blackburn reviewed the current status of Animal Salmonellosis in the United States. A complete report will be published in the proceedings of the 87th annual meeting of the USAHA. *Salmonella dublin* in cattle appears to be spreading to new states but less rapidly than in recent years. In FY83, isolations were reported in 20 states. He also noted that based on DNA homology studies, Arizona species should be properly classified as salmonella. Beginning October 1, 1983, the reporting of Arizona serotyping has been changed to be compatible to changes instituted at the Centers for Disease Control, USPHS, Atlanta, GA. *S. hadar* has now been recognized in 14 states since it was first recognized in the U.S. in turkeys in 1979. For the first time (FY 1983) it has been isolated from chickens, mink, pigeons and geese. Turkey is the most common host. CDC in 1980 reported 47 human cases and isolations from 13 states since its first recognition in humans in U.S. in 1976.

2. Dr. Morris Potter, Division of Bacterial Diseases, Center for Infectious Diseases, Centers for Disease Control, reported that the Center had investigated 48 salmonella outbreaks in humans from 1972–1983, usually involving antimicrobial resistant salmonellae. Of the 29 community based outbreaks where a source could be identified, food producing animals were implicated in 16 of the outbreaks and in many of the others, there was reasonable evidence that the person to person transmission was ultimately derived from animal reservoirs.

Two recent investigations provided examples of improved epidemiologic abilities brought on by new technology. In one, a raw milk associated outbreak of *S. typhimurium* induced disease, a distinctive antimicrobial pattern identified a number of isolates as potentially outbreak related; plasmid studies helped clarify the epidemiologic analysis by demonstrating that individuals who could not be related to the outbreak epidemiologically had isolates with different plasmid profiles than the epidemiologically-linked isolates.

In a recent investigation (1982–83), two clusters of multiply-resistant *S. newport* infections linked to consumption of ground beef was revealed by a combination of plasmid analysis and computerized sales records which permitted the traceback of the implicated ground beef from the stores through a series of transactions to the farm of origin.

Although complicated modes of transmission may contrive to impede epidemiologic investigations of salmonellosis, the availability of new techniques has exciting implications for both human and animal health.
Communications between NVSL and CDC during these investigations have been excellent, but full development of the data has been hampered by a lack of epidemiologic support at NVSL and in VS-APHIS-USDA.

3. Mr. Alan H. Bentley, Coordinator of the Salmonella Unit, Agriculture Canada provided a progress report on the Canadian Salmonella Program. He commented on the need for education of personnel in various segments of livestock and poultry industries to develop integrated efforts to secure microbiological control at all segments of the agri-food industry. They have already developed five audio visual training sets and are preparing three more. He reported briefly on several areas of investigation on Salmonella control.

Two resolutions were passed by the 1982 USAHA Executive Board that dealt with aspects of the Salmonella problem.


Dr. W. B. Bixler, BVM-FDA indicated that he will be meeting the week of October 21, 1983 with representatives of the National Renderers Association to initiate a discussion on sanitation guidelines for use by rendering industries including informational materials.

Resolution 2. Assignment of one or more epidemiologists by USDA-APHIS-VS to conduct field investigations to analyze all available data and to determine economic impact of animal salmonellosis such as *Salmonella dublin* in cattle and swine.

Dr. I. L. Peterson USDA-APHIS-VS indicated to the committee “Until new information is presented indicating practical or effective control measures or until a major poultry or livestock disease problem occurs due to salmonella, Veterinary Services is unable to provide epidemiologists to analyze salmonella infection.”

The Committee, after considerable discussion, reaffirmed its 1982 position as stated in the above resolution approved by the USAHA Executive Board.

**SUBCOMMITTEE REPORTS**

Dr. M. S. Cover, Chairman of Subcommittee on Feeds and Feed Ingredients reported for this Subcommittee and introduced Dr. Fred Bisplinghoff, Chairman of the Salmonella Committee of the National Renderers Association.

Dr. Bisplinghoff reported that Salmonella Committee of NRA has been recently formed with the objectives to undertake many activities to improve the microbiological quality of animal by-products. He emphasized the importance of continuing communications with USDA, FDA and the Committee on Salmonella of USAHA. The Committee was very pleased with the constructive action being taken by the NRA.

Dr. W. H. Dubbert, Chairman of the Subcommittee on Processing,
reported that FSIS-USDA has undertaken several “bench mark” projects to determine the level of salmonella in broilers. Details of these studies will be found in the paper to be published in the proceedings of the 87th annual meeting of USAHA.

The Food Safety and Inspection Service again in 1984 will give top priority to salmonella research projects with particular emphasis on feed processing projects. These will include the effect of fat levels, processing temperature and die size that may influence feed pelletizing operations.

On June 1, 1983, FSIS published final regulations that clarified existing rules establishing production requirements for cooked beef, roast beef and cooked corned beef. The actions were taken following several instances during the past few years of salmonella being isolated in cooked beef products.

Mr. C. W. Weston, Chairman of the Subcommittee on Poultry Breeders, reported that *S. gallinarum* (Fowl Typhoid) had not been detected in commercial poultry flocks for 10 years and no isolations from any poultry flocks for the past three years. Because of the high frequency of fowl typhoid in poultry in Latin American countries and the threat of extension of this highly damaging disease to poultry in U.S., a resolution was approved by the Committee which would require that identified cases of fowl typhoid would be treated as a foreign disease but that a suitable program be developed for salvaging critical genetic stock which became infected. This resolution has been referred to the Resolutions Committee.

Dr. L. C. Grumbles reported that in Texas they have found a high incidence of *S. pullorum* in poultry offered in Flea Markets. Recently, infection of two commercial breeding flocks have occurred and investigations have suggested that infection may have originated from a back yard flock.

Mr. Ray Schar, Coordinator of the National Poultry Improvement Plan reported the encouraging progress that:

1. Two states were in the final states of review for acceptance as U.S. Pullorum-Typhoid Clean States and six additional states were in earlier stages of review.

Dr. Glenn Snoeyenbos, Chairman of the Subcommittee on Research outlined recent changes of federal funding for salmonella research at the production level which has declined to an exceedingly low level. There is, however, substantial funding of research in postharvest technology and pasteurization of feeds.

Dr. Erskine Morse submitted the following report:

*Salmonella dublin* infections have more or less diminished in Northern Indiana cattle. Reporting is no doubt the true cause of the decrease in prevalence. Samples are not being sent to the Purdue Diagnostic Laboratory. One severe salmonellosis outbreak did occur near Elkhart, Indiana. This is in the *S. dublin* area of the state — where 26 outbreaks have been found. Adult cattle died as well as calves. Finally, *S. dublin* was diagnosed.
in cattle in mid-central Indiana, near Lafayette. Two of three calves purchased at a sale barn died. This minor bovine outbreak is the first seen south of the upper tier of Northern Indiana counties.

*Salmonella muenchen* (0 Group C2) is found in epizootic proportions in Indiana cattle. It is being observed in horses and swine as well. This salmonellae is highly contagious for man and other animals. Pathogenicity of individual strains varies considerably — some, once established in a bovine or porcine herd are quite virulent for young animals. The disease in adult animals can be mild and transient. The carrier state is the general rule for this serotype. Shedding has been observed for 1–3 months. The agent persists in the herd for a number of months. It is readily transferred from species to species.

Dr. E. T. Mallinson, Chairman of the Subcommittee on Extension-Education reported that the subcommittee membership has been structured to give strong emphasis to the expertise available from persons with a strong background in both salmonellosis and extension, undergirded further by those with specific training in poultry and livestock production and economics.

The reason to bring an extension-education emphasis to the salmonella problem has been stimulated by international reports and U.S. feasibility studies indicating that reasonable sanitation improvements or as called “Total Microbiological Control” in Canada, not only led to reduction in salmonella but appeared frequently to be associated with rather significant improvements in over-all flock performance. This latter improvement was suspected to be the result of lowering exposure levels to various agents and not just to salmonella reduction alone.

The Subcommittee has set a goal to explore the cost-benefit effect of so to speak, Total Microbiological Control type programs. Particular attention will be given to benchmark assessments of costs and changes in flock performance and the incidence of salmonellosis. There is great interest in the professionally developed employee targeted audio visual aids developed in Canada for overall improvement of farm hygiene. Application of similar educational aids in the U.S. will be the subject of a key Salmonella Subcommittee meeting planned for February, 1984.

The committee took action on a resolution dealing with USAHA serving as a co-sponsor of the International Symposium on Salmonella. This resolution was referred to the Resolutions Committee.

The following Subcommittees were formed in 1983:


**REGULATORY PROGRAMS:**

REPORT OF THE COMMITTEE


INDUSTRY:


POULTRY BREEDERS: C. R. Weston, Chairperson, R. Nicholas, I. L. Peterson and R. Schar.


EXTENSION-EDUCATION: E. T. Mallinson, Chairperson.
A REVIEW OF THE BLUETONGUE PROGRAM IN CALIFORNIA: STUDIES IN SHEEP

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Bluetongue (BT) is an insect-borne viral disease of ruminants in many countries with temperate climates. The disease was first recognized to occur in California sheep in the early 1950's¹; however, soremuzzle, a disease resembling BT, was reported earlier in Texas.² Shortly after the isolation of bluetongue virus (BTV) from sheep, a chick embryo modified-live virus vaccine (BTV-10) was developed and used.³⁴

Subsequent studies revealed that there were a number of different serotypes of BTV responsible for infection and 4 of the serotypes were in the United States.⁵ The original isolate was identified as serotype 10, with subsequent isolates being serotype 11, 13 and 17. Recently serotype 2 was isolated from cattle in Florida.⁶

In 1977, concern was expressed by sheep producers in California, that the BTV-10 vaccine was not effective in controlling outbreaks of bluetongue. At the time, all 4 BTV serotypes known to occur in the US had not been isolated from ruminants in California.⁵ Attempts to identify BTV infection by laboratory confirmation were limited. Prompted by this, a proposal was drawn up to: 1) develop improved, cost-effective, accurate diagnostic techniques, 2) implement an epidemiologic study to better define the problem, and 3) initiate control procedures either through vaccination or insect-vector control.

In this report we will review the progress made over the last six years. This research was a cooperative program and supported by USDA/ARS, USDA/APHIS, USDA Special Grants, USDA Animal Health Formula Program and Commodity Groups such as the California Woolgrowers Association, California Cattleman's Association, California Milk Advisory Board, California Holstein Association, artificial insemination Units, the State of California and the Livestock Disease Research Laboratory of the University of California.

DIAGNOSTIC TESTS

Most diagnostic laboratories do not make a concerted effort to diagnose BT. Presently, the only sure way of diagnosing BTV infection is by virus isolation. In the U.S., inoculation of 11-day-old embryonated chicken eggs (ECE) has given the most consistent results for confirming BTV infection.⁷
Although this method is reliable it is costly, time consuming and many laboratories do not have access to a supply of embryonated eggs. More often than not, the bluetongue immunodiffusion test (BTID) and/or gross and microscopic pathology are the means of diagnosis. These procedures are limited in scope and fail to accurately identify the particular serotype of virus causing infection. Serological tests such as bluetongue immunodiffusion (BTID) and virus neutralization indicate that virus infection has occurred; however, approximately 25% of the sheep with active BTV infection, do not have demonstrable BTID antibodies.

Procedures which have been developed and applied to BTV diagnostics through the collaborative program at Davis include: 1) development of a disc virus neutralization test for serotyping BTV isolates, 2) application of an automated enzyme-linked immunosorbent assay (ELISA) for identifying antibodies to BTV group antigens, 3) development of assays for identifying cell-mediated immune responses to BTV in sheep, 4) application of a rapid, cost-effective procedure for characterizing BTV genome segments, 5) adaptation and modification of a rapid immunoblotting technique for characterizing immune responses to BT viral subunits, 6) preparation of monoclonal antibodies to BTV 17 and 13, and 7) adaptation of a peroxidase-anti-peroxidase (PAP) method for detecting BTV in formalin-fixed tissues.

The disc method for serotyping BTV isolates from the field is rapid and relatively inexpensive. The procedure has made it possible to serotype isolates in 5 to 7 days rather than the two weeks or longer by the more cumbersome virus neutralization test. An electropherotyping procedure, used for identifying BTV genome segments, has been modified such that the use of radiolabelled isotopes is no longer necessary. In addition, the time to carry out the procedure has been reduced from 10 days to 24 hours. The procedure can be carried out in laboratories without sophisticated equipment. In an effort to find a rapid and relatively inexpensive method for characterizing immune responses to BTV subunits, an immunoblotting technique has been developed which eliminates the need for radiolabelled substrates, thereby reducing the time to run the assays from 7 days to 24 hours. The immunoblotting technique can be used to better characterize immune responses to individual virus proteins. Identification of those protein subunits which are important for protective immunity will facilitate the development of highly specific diagnostic reagents.

An ELISA system has been developed to provide a rapid accurate serologic test for antibodies to BTV group antigens. The advantage of this test over the BTID test is that large numbers of samples can be performed at once, the results interpreted in a matter of hours and the results are quantitative. The test can be used for diagnostic purposes and for epidemiologic studies.

Monoclonal antibodies have been prepared in order to provide specific diagnostic reagents. For instance, these monoclonals can be used to identify BTV infected cells in blood. Adaptation of the peroxidase-anti-peroxidase (PAP) system for identification of BTV antigen in formalin-
fixed tissue specimens provides an important new technique for diagnosing BT. This procedure can be readily used on necropsy specimens and samples collected from aborted fetuses. With monoclonals and enzyme-linked assays it should be possible to develop a diagnostic reagent kit that can be applied at the side of the animal.

**EPIDEMIOLOGY**

At the initiation of the California studies, knowledge of the prevalence and distribution of BTV infection was sketchy. Most information was based on clinical impressions and submission of the occasional sample to diagnostic laboratories. If virus was isolated, many times the serotype causing infection was not identified.

Some of the information, relating to sheep, derived from a study supported by USDA/APHIS included: 1) an indication of the prevalence of infection, 2) characterization of the BTV serotypes causing infection, 3) demonstration of seasonal variations of infection, 4) demonstration of the movement of BTV, 5) recognition of multiple serotype infections, 6) confirmation of genetic variability of BTV isolates, 7) the first report of clinically inapparent BTV infection of sheep in the U.S., 8) isolation of the 4 BTV serotypes from Culicoides in California and 9) reporting of BTV outbreaks in flocks vaccinated with the homologous serotype of modified live virus vaccine.

Over a 3 year period, 12,000 blood and serum samples collected from sheep were evaluated for evidence of BTV infection. Both virus isolation and the BTID antibody tests were performed on all samples. The sampling indicated that BTV infection occurred in all but 2 counties which were in Northwestern California. One hundred and seventy three BTV isolates were made over the 3 years and 39.8% of all sheep tested were serologically positive by the BTID test. Seasonal variation in the percentage of sheep with BTID antibodies were observed. Thirty two percent of the sheep sampled from January through June had BTID antibodies whereas 47% of the animals sampled from July to December were seropositive. Two of the 173 virus isolates were made in June and no isolates were made during the months of January to May. The remaining 171 isolates were made in the summer and fall months.

This study was undertaken because the BTV-10 modified live virus vaccine appeared ineffective in the prevention of BT disease. Virus isolations over the 3 years provided the basis for understanding the reason that the vaccine was ineffective. Of the 173 virus isolates, 92 (53%) were due to BTV-11, 34 (23%) to BTV-17, 21 (12%) to BTV-13 and 20 (11%) to BTV-10. BTV-11 was the most frequently isolated virus, followed by BTV-17, in each of the 3 consecutive years of the study. Since there is little cross-protective immunity between these viruses, it is likely that the vaccine had little effect on curbing BTV infection.

Another startling fact was that on at least 30% of the ranches from which BTV was isolated, multiple BTV serotypes were isolated from the flocks. In some instances, sheep were found that were infected with 2
different BTV serotypes at the same bleeding. This again suggests that vaccination against one BTV serotype will probably not provide sufficient protection against the other serotypes.

Introduction of BTV into an area has been reported to be the result of transmission by insect vectors. In one outbreak of BT in a sheep flock the virus was introduced with a viremic sheep. Within 2 weeks after this sick sheep arrived, the resident population developed BT. Contrary to popular belief, not all BTV infection leads to disease in sheep as different flocks infected with BTV had no clinical evidence of BT lesions. Since active BTV infection apparently occurs in the absence of disease, clinical examination alone is not sufficient for preventing the movement and eventual introduction of the virus into susceptible flocks. Control of movement of BTV can only be brought about through the use of rapid, animal-slide diagnostic kits.

An evaluation of the gene profiles of BTV isolated from sheep indicated that there is considerable variability in gene segment mobility within serotypes. The most stable genome profiles were obtained with BTV-17. The other 3 serotypes had considerable variability in gene segment 5 which codes for subunit protein 5 (P5). The significance of this observation is not understood; however it may account for the failure of some of the modified live virus (MLV) vaccines to prevent subsequent infection and disease. In our studies, there were flocks which had been vaccinated with the MLV vaccines in the spring. Later in the summer these same flocks had BT disease from which virus, homologous in serotype to the BTV vaccine, was isolated. It is also conceivable that these genetic variations may be associated with pathogenic expression of the particular virus isolate. Further work on genetic analysis and gene expression should provide insight on these problems.

CONTROL

The two proposed means of controlling BTV infection are through vaccination and/or insect vector control. Both approaches have complicating factors. Culicoides variipennis, the vector in California, is found from sea-level to 10,000 feet and can be found in most areas of the state. Extensive irrigation practiced in most of California provides ample breeding sites for the vectors. Vaccination is complicated by the presence of 4, and possibly 5, different serotypes of virus, each capable of causing disease. Vaccination with one serotype does not provide protection for the other serotypes.

Emphasis of the program in California has focused on vaccination. The major accomplishments include: 1) collaborating with Dr. T. L. Barber, Arthropod-Borne Animal Disease Research Laboratory, Denver in testing inactivated BTV vaccines, 2) demonstrating cell-mediated immune response to vaccine virus, 3) demonstrating protection in the absence of neutralizing antibody, 4) demonstrating breed differences in immune responses to inactivated BTV vaccines, 5) providing background in-
formation for modified live virus vaccine programs and 6) testing 3 modified live virus vaccines for safety and efficacy.

BTV inactivated with binary ethylenimine (BEI) provides reasonably good protection. The unique qualities of the vaccine included the stimulation of a measurable cell-mediated immunity and BTID antibody responses in the absence of neutralizing antibody. There was a marked difference in the ability of different breeds of sheep to respond to the vaccine. BTID seroconversions occurred in 90% of Columbia and Finn sheep vaccinated with BTV with aluminum hydroxide as the adjuvant. In contrast, only 30% of the Suffolk and Hampshire breeds seroconverted with the same vaccine. In field trials, BT outbreaks were not observed to occur in flocks which received the serotypes included in the vaccines. The major advantage of inactivated vaccines is that it does not cause post-vaccinal viremias which can be picked up by Culicoides vectors and transmitted to susceptible animals. In addition, there is no adverse post-vaccinal effects.

In an attempt to assist producers in providing protection from future BTV outbreaks, the epidemiological data collected from the survey was provided to the industry, i.e. that BTV-11 and -17 accounted for over 75% of the virus isolates from sheep. A local vaccine company obtained BTV-11 and -17 and prepared modified live virus vaccines. The School of Veterinary Medicine then tested the vaccines using safety and efficacy standards established by the California Department of Food and Agriculture. As a consequence, MLV vaccines are now available in California to 88% of the BTV isolates made from sheep. Current work is focusing on recombinant DNA technology to provide products which may serve as safe and effective vaccines. Hopefully, this will provide the most desirable product(s) for safe and protective immunity.

SUMMARY AND CONCLUSIONS

The School of Veterinary Medicine, University of California undertook a collaborative seven-year program to address bluetongue in California. The major objectives were to: 1) develop rapid, simple and effective diagnostic procedures, 2) define the epizootiology of BT and 3) devise appropriate control measures. In this report the results directly relating to the sheep industry were discussed. Although funding for these programs has been erratic, significant progress has been made in those areas where reasonable support was available. Because of lack of total support and agency priorities, not all of the goals have been attained as originally projected.

REFERENCES


A PERSPECTIVE OF SCRAPIE AS AN INFECTIOUS DISEASE OF SHEEP AND GOATS

W. J. Hadlow

Department of Health and Human Services, Public Health Service, National Institutes of Health, National Institute of Allergy and Infectious Diseases, Epidemiology Branch, Rocky Mountain Laboratories, Hamilton, Montana 59840.

Despite all the study scrapie has received during the past 20 years, this slow infectious disease of sheep and goats is still poorly understood. I think this is so for two main reasons: (1) The absence of any detectable immune response to scrapie virus infection. As a consequence, no serologic test is available to identify exposed animals at any stage of the infection (preclinical, clinical, subclinical) or afterward if it subsides. (2) Lack of a convenient system for detecting and assaying scrapie virus. Although the virus replicates slowly in certain cell cultures, this method is not useful for detecting the virus or for producing large amounts of it for special studies. Inoculation of the mouse is the only practical detection method available, but it has definite drawbacks. For example, the incubation period is 12 to 16 months in Swiss mice inoculated intracerebrally with tissues from naturally infected sheep and goats. Nevertheless, when information on the natural infection is sought, much can still be gained by using the bioassay.

Together, these limitations have hampered not only field work involving diagnosis and epidemiologic studies, but also experimental work on the disease and its unconventional causative virus. Not having simple laboratory tests for antibody or virus, investigators have been stymied in their desire to learn more about scrapie. As a consequence, most have shied away from doing so. A few persons, less discouraged by these limitations, have become preoccupied either with convenient laboratory models of scrapie or with the causative virus. And however laudable their work has been, so far it has provided few answers to the many questions that still haunt sheep breeder and disease investigator alike. Such is the dilemma in 1983: Information on the infection in the natural hosts either has not been sought by using the cumbersome methods at hand or has not been obtained simply because standard virologic methods can not be applied to the problem.

Too often in our eagerness to explore a small part of the problem in the laboratory, we may forget that, despite some extant misinformation to the contrary, scrapie is an infectious, contagious disease about which certain things need to be known if we are to understand it. Cedric Mims, a medical virologist with an abiding concern for the pathogenesis of infectious disease, drew attention to these needs and pointed out how woefully inadequate our understanding of scrapie is. My coworkers and I have long shared his views, and in the comments that follow, I have expanded his general theme in considering scrapie as a typical infectious disease, albeit with several unusual features. In doing so, I have relied mostly on
fragmentary virologic findings in Suffolk sheep and dairy goats living with them. Although the findings in several other breeds of sheep are less clear-cut, I would be surprised if the general pattern of events in them differed greatly from that outlined here.

Long ago from a source now forgotten, I copied a list of questions concerning what needs to be known about any viral disease. Several of these questions are especially relevant to this consideration of scrapie.

What happens to the virus during the two-to four-year incubation period? An early study in the mouse provided the clue. Long before disease supervenes, in fact long before the central nervous system (CNS) becomes infected, scrapie virus replicates in extraneural tissues. In naturally infected Suffolk sheep, virus was first found there in clinically normal lambs 10 to 14 months old. At that age, it was present only in lymphoreticular tissue and intestine, always in low concentrations. Almost invariably, the spleen and the retropharyngeal and mesenteric lymph nodes were infected. In time, virus spreads to other lymph nodes but rarely to other extraneural organs. Obviously not affected adversely by any of the host's defense mechanisms, the virus continues to multiply in the lymphoreticular tissue and intestine for months or even years before it reaches the CNS—the only site where damage is done.

Although the virus has not been found in the blood of sheep and goats, it probably is carried to the target organ by the circulating blood, as in most viral infections of the CNS. Infrequent passage of virus into the blood and then only in amounts easily missed by the bioassay may account for the failure to detect viremia. But these conditions may not provide enough virus circulating sufficiently long to infect the CNS. If the virus is cell-associated, techniques other than those used so far may be required to detect it in the blood. As yet, no one has offered evidence that the virus passes along peripheral nerves to reach the CNS, as has been suggested for the infection in the mouse. Nevertheless, the detection of CNS virus first in the brain stem of sheep and goats at least raises the possibility of its passage along cranial nerves from sites of replication in the oropharynx.

Regardless of the pathway of spread, the long period of primary replication outside the CNS is then followed by secondary replication in the brain and spinal cord. It was first found in a 25-month-old clinically normal Suffolk ewe that had small amounts of virus in the brain stem and thalamus. Then in any of several possible ways, the virus spreads to other parts of the CNS, where it replicates to concentrations much higher than those found extraneurally. No doubt virus replicates in the CNS for many months before its concentration in critical parts of the brain is enough to cause disease, which occurs in most sheep and goats when they are 30 to 60 months old. In the end, the highest concentrations of virus are found in those parts of the brain that suffer the greatest damage. Their altered function gives rise to the characteristic clinical signs. Significantly, throughout the long course of the infection, virus continues to replicate in extraneural sites; it is not cleared from them once it reaches
the CNS and disease supervenes. If accompanied by shedding, such persisting virus would have important implications for transmission.

Is infection of the CNS a normal and regular consequence of virus replication in extraneural tissues? If not, does the extraneural infection usually run a harmless course and disappear without leaving telltale serologic evidence, or does it persist for an indefinite period as a subclinical infection that never gives rise to disease? If it remains as an inapparent infection, is virus shed to the outside where it may then infect other sheep in the flock? Little is known about these possibilities, except that no evidence of a carrier state was found in 17 clinically normal high-risk Suffolk rams and ewes 54 to 104 months old. No doubt all had been exposed to scrapie virus, for the parents of 11 and the progeny of at least 4 ewes died of scrapie. Subclinical infection also was unlikely in experimentally inoculated goats in which extraneural replication of virus was always followed by infection of the CNS. In some mice, the period between inoculation and the first detection of infectious virus in extraneural tissues may be exceedingly long—about half the life span of the mouse—so disease may never supervene before the mouse dies of old age. If such a greatly delayed preclinical infection occurs in natural scrapie, it might be mistaken for a persistent subclinical infection in older sheep and goats.

If scrapie is naturally transmissible, how is the virus passed on to the next host? In two ways: vertically and horizontally. The long-recognized strong familial occurrence of the disease usually has been considered evidence of vertical transmission. Broadly defined, this term includes infection that occurs before birth as well as during and shortly after birth. Although the epidemiologic importance of the close association of an infected ewe with her lamb is well documented, virologic evidence supporting any one mode of such “maternal transmission” is lacking. Prenatal infection can result from virus replicating in the endometrium or in the placenta or from virus transmitted through the ovum and sperm (germ line transmission). Virus was not detected in fetuses of affected ewes or in newborn lambs from high-risk Suffolk families. Nor was it detected in the ovaries or endometrium of affected ewes and does. Similarly, virus was not found in the testis or seminal vesicle of an affected Suffolk ram or in the testes and semen of others. Nasal and oropharyngeal secretions are possible sources of excreted virus that might infect a lamb or kid at birth when it is licked and nuzzled by its mother. This possibility is supported by finding small amounts of virus in the nasal mucosa of some sheep and goats affected with scrapie. Then too, during the early postnatal period, the nursing lamb or kid might become infected from its mother’s milk, but supporting virologic evidence is lacking. Virus was not detected in the mammary glands of two non-pregnant ewes and three lactating does suffering from scrapie. Nor was it detected in the colostrum of six high-risk Suffolk ewes.

However important vertical transmission is, horizontal transmission is now known to occur as well. This has been especially well documented
at the Scrapie Field Trial, Mission, Texas, where virus spread from sheep to sheep and from sheep to goats in an infected Suffolk flock kept on pastureland. Yet, scrapie is not highly contagious, at least as reckoned by the occurrence of overt disease. The precise conditions necessary for such spread are uncertain, but information on extraneural replication of virus is essential to explain it.

Little is known about the shedding of scrapie virus to the outside world—the crucial event if horizontal transmission is to happen. The nasal mucosa might be a source of excreted virus, for it has been infected fairly often in sick animals, as already mentioned. Virus has not been detected in the kidneys, urine, saliva, salivary glands, or feces of naturally infected sheep and goats. Its regular presence in intestinal tissue of these animals, however, suggests that the alimentary tract is a likely site from which virus is shed to the outside. From early in the infection, moderate concentrations of virus are found there. Which cells in the wall of the ileum and proximal colon, the intestinal segments with the most virus, support replication is not known. In both, the submucosa is rich in lymphatic tissue, especially in young sheep and goats. Perhaps virus replicates mainly there rather than in the mucosal epithelium, from which it would be shed more readily into the lumen of the bowel. If virus is excreted in feces, infected sheep and goats would be a threat to others long before disease supervenes, for maximal concentrations in the intestine appear early in the infection and remain throughout its long course. Because virus may not be distributed uniformly in the contents of the distal intestinal tract and may occur there only in low concentrations, efforts more assiduous than those used hitherto (including mine) no doubt will be needed to find virus in feces.

How does the virus actually enter the body to cause infection by these modes of transmission? Probably by the way of the alimentary tract, for the virologic findings in naturally infected Suffolk sheep point to the oropharynx or intestine, or both, as the site where replication begins. If this is so prenatally and accounts for vertical transmission, virus perforce must gain access to the amniotic fluid, which the fetus normally swallows. Presumably, such virus would come from sites of replication in the endometrium or the placenta, or both. In naturally infected animals, virus has been found only in the placenta; it was detected in six Swaledale ewes by oral and intracerebral inoculation of sheep and goats and in one doe by inoculation of mice. But as yet, virus has not been detected in the placentas of affected Suffolk ewes. How and when intrauterine infection occurs and at what gestational age the fetus supposedly becomes infected in this way are questions still unanswered. For most viral infections of the fetus, viremia in the mother is necessary. As mentioned earlier, this has not been detected in either sheep or goats.

Other than that which might be in milk, virus entering the alimentary tract postnatally no doubt comes from an environment contaminated with feces and perhaps also with nasal secretions and fetal membranes. At the Scrapie Field Trial, such infection occurred more readily when lambs were
exposed to virus early in life than when first exposed after weaning.\(^ {17} \) And the longer they were exposed to a contaminated environment, the greater the percentage of them that succumbed to scrapie. No doubt this increased morbidity occurs because contact with virus is repeated, however haphazard. How long sheep and goats remain susceptible to infection when exposed orally under natural conditions is not certain, but the general impression is that susceptibility declines with increasing age after birth.\(^ {6} \)

None of the studies on experimental oral transmission of scrapie provided a clue about the infective dose of virus by this route.\(^ {27,28} \)

In my experience with the present bioassay, virus is seldom detectable in naturally infected sheep and goats before they become about nine months old. Hence, learning about the onset and early events of the infectious process is virtually impossible.\(^ {12} \) Indeed, the question of vertical transmission of scrapie may never be answered by efforts to demonstrate fetal infection by detecting virus, the observations on placental infection notwithstanding. Most likely, the phenomenon called the "zero phase" of the infectious process explains this failure to detect virus in fetuses, newborns, and even weaned lambs and kids.\(^ {5,20} \) As observed experimentally in mice, sheep, and goats, a period of weeks or months—the "zero phase"—elapses between inoculation of virus and its subsequent detection by bioassay.\(^ {7,10,12} \) In mice, for example, the difference between long and short incubation periods is attributable to the duration of the "zero phase", which may take up half the lifespan of the mouse, as mentioned earlier. If a prolonged "zero phase" occurs during natural infections, it could account for scrapie appearing long after the age when the disease is most prevalent.\(^ {3,17} \) Although explanations have been proposed for this phenomenon, nothing is known about what actually happens to the virus before its replication becomes detectable by mouse inoculation.\(^ {16} \)

Up to now, I have considered scrapie a specific infectious disease caused by an unconventional virus. Yet, because it lacks laboratory diagnostic features, scrapie must be dealt with practically as nothing more than a clinicopathologic entity. That is, it is a recognizable combination of clinical signs accompanying characteristic, though largely nonspecific, histologic changes in the brain.\(^ {2} \) It occurs in a certain epidemiologic setting but is without specific manifestations testable in the laboratory. And to complicate matters more, in some sheep the clinical picture may not be as stereotyped nor the lesions in the brain as easily demonstrable as often described.\(^ {3,8} \) The only recourse in identifying scrapie more conclusively is detection of the causative virus by bioassay. But as mentioned earlier, this is not practical as a routine diagnostic procedure.

Moreover, at present the virus(es) causing natural scrapie in sheep and goats cannot be distinguished unequivocally from similar viruses causing comparable diseases in man.\(^ {9} \) In fact, some isolates of the human viruses cause a neurologic disease in goats that is indistinguishable from scrapie clinically and neurohistologically.\(^ {14} \) Quite naturally, such findings have provoked much speculation about the epidemiologic and public health implications of this likeness.\(^ {1} \) Also in view of such findings, perhaps
scrapie is less a specific etiologic entity than it is a clinicopathologic one. In other words, several related viruses may give rise to the one disease we recognize as scrapie. This is now an accepted concept of infectious disease, however contrary it may be to Koch's postulates. These remarks are not intended to imply, or even suggest, that scrapie cannot be diagnosed with assurance in the field. Except for the inevitable problem cases, it can be diagnosed without great difficulty by considering the history, clinical picture, and neurohistologic changes. And besides, diagnosing the disease postmortem is not the real concern anyway. The real concern is detecting scrapie virus infection, especially in clinically normal animals. And I offer these comments to emphasize the need for more information on ways to do this, so control or eradication of the disease becomes a more achievable goal than it is now. Whether this goal is accomplished by judicious culling or by increasing resistance genetically (where this is feasible), tests that identify infected animals, healthy and sick alike, will be the key to success. By either approach, sole dependence on recognizing only overt disease will not be good enough. Most persons who understand the problem already know that.

The foregoing commentary is one man's perspective of scrapie as an infectious disease of sheep and goats. It seems a reasonable interpretation of the meager information available. Obviously, though, more information is needed to confirm my largely tentative conclusions and to answer questions I did not ask. But, for reasons mentioned at the outset, I think the prospect for obtaining such information soon is mighty bleak. Meanwhile, we must look hopefully to those few persons concerned with the laboratory models or with the causative virus for findings that might enhance our understanding of scrapie as a naturally occurring infectious disease.

REFERENCES


REPORT OF THE COMMITTEE ON SHEEP AND GOATS

Chairman: Michele C. Howard, Sacramento, CA
Vice Chairman: J. R. Pitcher, Hyattsville, MD

J. A. Acree, MD; Stan Allen, UT; A. A. Anderson, MD; M. H. Bairey, IA; R. B. Bushnell, CA; J. E. Fox, GA; William Hadlow, MT; R. F. Hall, GA; J. N. Huff, CO; M. M. Jochim, CO; Hyram Kitchen, TN; W. A. Knapp, Jr., NC; Blaine McGowan, CA; Mort Mertz, TX; J. H. Niemi, SD; G. E. Reynolds, OR; F. James Schoenfeld, UT; A. W. Smith, OR; D. H. Smith, WA; T. B. Snodgrass, TX; Jeff Stott, CA; O. H. Timm, CA; P. R. Turner, TX; H. W. Whitford, TX

The Sheep and Goat Committee met at 1:30 on Monday, October 17, 1983. There were 18 members present and 35 guests for a total of 53 people.

The committee met as requested by the president of USAHA to consider the business of the committee, and submits the following report:

Dr. William Hadlow gave us a perspective of scrapie as an infectious disease of sheep and goats. Despite all the study scrapie has received during the past 20 years, this slow, infectious disease of sheep and goats is still poorly understood for two main reasons — 1) The absence of any detectable immune response to scrapie virus infection and 2) lack of a convenient system for detecting and isolating scrapie virus. Dr. Hadlow did not intend to imply that scrapie cannot be diagnosed with assurance in the field. Diagnosing the disease post mortem is not the real concern. The real concern is detecting scrapie virus infection in clinically normal animals. Tests that identify infected animals, healthy and sick alike, will be the key to success.

A report on the Scrapie Program was presented by Dr. J. R. Pitcher. During fiscal year 1983, 15 outbreaks of scrapie were confirmed in 10 states. The cases were distributed as follows: Illinois-1, Indiana-2, Louisiana-1, Massachusetts-1, Michigan-1, New Jersey-1, Oklahoma-3, Texas-1, Virginia-2, and Wisconsin-2. The Scrapie Program was changed to a bloodline program April 15, 1983.

A summary of information of Bluetongue disease in sheep was given by Dr. Jeff Stott. A study which began as an epidemiological study 7 years ago has demonstrated infection of sheep and goats with 4 serotypes of Bluetongue viruses (types 11-17-13 and 10). Three modified-live Bluetongue virus vaccines have been developed and are being used in California for types 10, 11, and 17. Research currently involves characterization of the immune response, and development and application of new and improved diagnostic techniques. In addition, serotypes 17 and 13 are being cloned, and this has potential for development of diagnostic reagents and genetically engineered sub unit vaccine. Limited field work is being conducted to identify the serotypes of BTV causing disease in sheep. A surveillance program to monitor for the presence of type 2 in California is also being initiated.

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Scientists at the Arthropod-borne Animal Diseases Research Laboratory in Denver, Colorado have isolated a Bluetongue virus from cattle in Florida that has never before been found in the Western Hemisphere. Dr. Lyn Barber reported that the genetic material from these virus isolates was undistinguishable from the 23 year old African prototype for serotype 2. Four of the virus isolates had differences that indicated that the virus has already undergone reassortment in the U.S. The genetic material from all serotype 2 isolates was markedly different from that of the 4 serotypes (10,11,13 & 17) known to exist in the U.S. These facts strongly suggest that the virus was introduced into the U.S., rather than evolving from the 4 serotypes that were already present. The discovery of Bluetongue virus serotype 2 poses a serious threat to the sheep, cattle and wildlife in the U.S., and its introduction may result in Bluetongue virus with characteristics different from those we have encountered in the past.

Dr. Cleon Kimberling, Extension Veterinarian, Colorado State University presented a timely program on the economic importance of evaluating rams for breeding soundness. Dr. Kimberling asked the question — “What is the cost of ram power to the average producer?” Management can influence fixed ram power cost factors by the ram to ewe ratio. Maximum ram utilization requires efficient, year-round management. Vaccination alone for ram epididymitis is not sufficient. A good program would also include palpation, semen evaluation, culling, parasite control and an adequate level of nutrition. Although vaccination has been widely used, recent trials with Brucella ovis bacterin demonstrated less than 60% efficacy.

Dr. Robert Jones, Research Entomologist from Colorado State University, reported on ram epididymitis caused by Brucella ovis and Lamb Epididymitis caused by non-Brucella organisms. Improved diagnostic methods are needed to identify the non-Brucella organisms. Improved serologic assays, and the institution and use of breeding soundness exams are also necessary. The importance of breeding soundness in sheep and goats is one of the resolutions passed by this committee.

In addition, resolutions were passed on Caprine Arthritis, Caseous Lymphadenitis, Internal Parasites of Sheep and Goats and Bluetongue.
VESICULAR STOMATITIS IN SWINE:
PATHOGENICITY OF AN EPIZOOTIC BOVINE STRAIN
VERSUS AN ENZOOTIC SWINE STRAIN

G. A. Erickson, DVM, PhD, M. L. Snyder, BA, J. I. Kresse, BS,  
E. W. Jenney, DVM and E. A. Carbrey, VMD, MS

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SUMMARY

Two strains of vesicular stomatitis—New Jersey (VS-NJ) virus, a bovine isolate from the 1982 western United States outbreak (VS-NJ/Durango/1983), and a feral pig isolate from Ossabaw Island, Georgia (VS-NJ/Ossabaw/1983), were compared in domestic pigs.

The 1982 isolate was also used to evaluate the susceptibility threshold of pigs to VS-NJ virus, and a lesion threshold was determined using the 1983 porcine isolate. Pigs responded serologically to 10 fetal swine kidney median tissue culture infective doses (TCID$_{50}$) of the 1982 isolate. Vesicular lesions observed in 1 pig inoculated with $10^6$ of the 1982 isolate developed only at the point of inoculation and did not spread to the feet.

The lesion threshold for the 1983 isolate was approximately $10^4$ TCID$_{50}$ and lesions were not observed at the site of inoculation with lower concentrations of the virus. Only 1 of 2 pigs inoculated with that dose developed erosive lesions. Pigs inoculated with $10^4$, $10^5$, and $10^6$ TCID$_{50}$ of this virus had generalized lesions on the snout. The lesions caused by this isolate were in sharp contrast to the lack of secondary spread from the injection sites on the snout of pigs inoculated with the 1982 bovine isolate.

INTRODUCTION

Vesicular stomatitis (VS) was first recognized as a disease of horses and later as a vesicular disease of swine and cattle. In swine, VS is clinically similar to foot-and-mouth disease, vesicular exanthema, and swine vesicular disease. In 1982, there was an extensive epizootic of New Jersey type VS (VS-NJ) in cattle and horses in the western United States, but the disease was not diagnosed in swine. Only 6 of the over 1200 investigations conducted from June 1982 through April 1983 involved swine and all were negative. However, 614 cases of VS-NJ were confirmed in cattle and horses. The majority of the positive cases were in Colorado, Idaho, Wyoming, New Mexico, Utah, Montana, and California. Contact spread of VS occurred through sale and movement of apparently healthy dairy cattle to dairies in New Mexico, Arizona, Oregon, Washington, Montana, Kansas, Nebraska, and California. The role of arthropod vectors was quite significant as demonstrated by the marked reduction in the number of new
cases in cattle after several killing frosts. Mechanical spread was presumably effected by 4 species of insects, *Musca domestica* (house fly), *Musca autumnalis* (face fly), *Anthomyiidae* spp. (a muscoid fly), and *Chloropidae* spp. (eye gnat), from which VS-NJ virus isolates were obtained by the Centers for Disease Control, Fort Collins, Colorado, and the Arthropod-borne Animal Disease Research Laboratory, Denver. Virus was also isolated from the biting midge, *Culicoides varipennis*, at Denver.a Despite these and other mechanisms of spread, the disease was not confirmed in swine. Similarly, swine cases have not been reported in Mexico during 1983 where VS-NJ is currently active in cattle.b

Since May 1983 laboratory confirmed cases of VS have not occurred in western United States. However, VS-NJ remains enzootic in wild swine in the southern United States, as confirmed by a recent serologic survey of the feral swine population that was conducted in 4 states, Arkansas, Louisiana, Florida, and Georgia,1 between January 1979 and November 1981. During that period, clinical VS was not observed in domestic livestock in those states. This was considered evidence that feral swine are sensitive serologic sentinels of VS-NJ virus activity.

Prior to 1983, clinical VS-NJ had been confirmed only once in feral swine on Champney Island, Georgia, in June 1957.1 In July 1983, clinical VS was observed in feral swine on Ossabaw Island, Georgia. Tissue specimens subsequently collected from 2 pigs were positive for VS-NJ virus isolation at the Plum Island Animal Disease Center, Greenport, New York, and the National Veterinary Services Laboratories (NVSL), Ames, Iowa. The NVSL isolate and a bovine isolate from the 1982 outbreak were used to evaluate the sensitivity and vesicular lesion thresholds of domestic swine in an attempt to define their risk of infection on premises with infected cattle and horses.

**Materials and Methods**

**Virus:**

Original isolate VS-NJ viruses, obtained in fetal swine kidney (FSK) cell cultures, were used for these studies. A bovine strain, VS-NJ/Durango/1982, was used in a susceptibility threshold study, and a porcine strain, VS-NJ/Ossabaw/1983, was used in a lesion threshold study.

**Animals:**

Five to 10 kg. swine free of antibodies to VS-NJ were used for inoculation. Each pig was maintained in a filtered air, negative pressure isolation cage. For inoculation, each pig was injected intradermally on the snout with a 1.0 ml inoculum distributed into a minimum of 5 sites.

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Experimental Design:

Susceptibility Threshold: VS-NJ/Durango/1982 virus was used for this study. Each of 3 pigs was inoculated with 1 of 3 inocula: $10^6$, $10^2$, and 10 median tissue culture infective doses (TCID$_{50}$) of virus. Tissue culture medium was inoculated into a fourth pig for a negative control.

Inoculated pigs were observed daily for the development and progression of vesicular lesions on the snout. Serum samples were collected for serology.

Lesion Threshold: VS-NJ/Ossabaw/1983 virus was used for this study. Two pigs each were inoculated with 1 of 6 inocula: $10^6$, $10^5$, $10^4$, $10^3$, $10^2$, or 10 TCID$_{50}$. A single pig was inoculated in the same manner using tap water. Each virus dose was titrated after pig inoculation to verify that the calculated dose was received by each pig.

Inoculated pigs were initially observed twice daily during lesion development and once daily on an intermittent basis thereafter. Body temperature was recorded daily. Serum samples were collected for serology.

Viral Assay and Serology:

Serial tenfold dilutions of each inoculum used in the lesion threshold study were inoculated into 4 tubes of FSK cell cultures per dilution. The cultures were observed daily for cytopathogenic effects due to VS-NJ as previously described. Neutralization assays were conducted as previously described.

Results

Susceptibility Threshold:

Pigs that received $10^6$, $10^2$, and 10 TCID$_{50}$ of virus developed antibodies against VS-NJ as shown in Figure 1. The pig that received tissue culture medium remained seronegative. Only the pig that received $10^6$ TCID$_{50}$ of VS-NJ/Durango/1982 virus developed vesicular lesions at the sites of inoculation by postinoculation day (PID) 2. By PID 4 one vesicle had ruptured and a second had enlarged to a $2.5 \times 1$ cm lesion. On PID 5 the second vesicle had ruptured and rapid healing of the lesion areas ensued. Healing was complete by PID 14 and no scar tissue was observed.

Lesion Threshold:

Titration of inocula verified that all pigs received the intended dose. Pigs receiving $10^6$ TCID$_{50}$ of VS-NJ/Ossabaw/1983 virus developed vesicles by PID 2 and 3. The 2 pigs receiving $10^5$ TCID$_{50}$ developed vesicles at PID 3 and 4. Only 1 of 2 pigs inoculated with $10^4$ TCID$_{50}$ developed a lesion. At the beginning of PID 2, serous rhinitis was observed in 1 of 2 pigs inoculated with $10^2$ TCID$_{50}$ of virus, and in all pigs that received $10^3$ TCID$_{50}$ or more virus. By the afternoon of PID 2 the rhinitis had diminished markedly, but by that time the other pig that received $10^2$ TCID$_{50}$ of virus had also developed a serous rhinitis. Later an intermittent serous rhinitis was observed in pigs receiving $10^4$ and
$10^6$ TCID$_{50}$ of virus. Mucopurulent nasal discharge was observed in both pigs receiving $10^6$ TCID$_{50}$ of virus from PID 3 through 6.

Secondary spread of vesicular lesions to adjacent areas of snout epithelium was observed in both pigs receiving $10^6$ TCID$_{50}$ of virus, and in 1 pig of each group receiving $10^5$ or $10^4$ TCID$_{50}$ of virus. In 2 pigs, secondary lesions continued to appear through PID 9. By PID 10 marked healing of lesions had occurred in the 5 affected pigs. At PID 14 residual tags of necrotic epithelium were present in the nostrils of 3 of the 5 pigs.

Of the pigs developing lesions, only the pigs receiving the $10^6$ TCID$_{50}$ dose had significant increases in body temperature (Figure 2). One pig had a peak body temperature of 41.2°C (106.2°F) at PID 5, while the second had a temperature of 39.9°C (103.8°F) at PID 4. In 4 pigs the appearance of vesicular lesions preceded peak body temperature (Figure 2); peak body temperatures were obtained just after the vesicles ruptured. The pig that received $10^4$ TCID$_{50}$ of virus developed an erosive lesion the day after its peak body temperature was observed.

Pigs receiving $10^3$, $10^2$, and $10$ TCID$_{50}$, as well as the tap water control pig, had essentially normal body temperatures from PID 1 through 8.

Neutralization assays confirmed that the virus replicated in pigs that received $10^2$ or more TCID$_{50}$ (Figure 3). The 10 TCID$_{50}$ pigs and the tap water control pig remained negative. Peak antibody titers were obtained by PID 14.

**DISCUSSION**

**Susceptibility Threshold:**

The magnitude of serologic response appeared to be somewhat dose-dependent for 2 lower doses, $10^1$ and $10^2$ TCID$_{50}$. The ability of the pig to develop antibodies against $10$ TCID$_{50}$ of virus confirmed the apparent sensitivity of feral swine as sentinels of enzootic VS-NJ virus activity in the southeastern United States.

Lack of secondary spread of the vesicular lesions in the $10^6$ TCID$_{50}$ pig inoculated with VS-NJ/Durango/1982 was also in sharp contrast to the results observed in the lesion threshold pigs. Since only 1 pig was inoculated, this may have been due to individual variation. Alternately, the lack of spread may reflect a lesser ability of bovine origin VS-NJ virus to infect swine tissue. Pig passage of the virus may be required to produce lesions similar to those observed for VS-NJ/Ossabaw/1983. Previously Holbrook, Geleta and Patterson had similar findings. In a typing study of VS field samples of swine origin, secondary vesicular lesions developed in 8 of 9 groups of pigs (4 per isolate) exposed to 9 geographically unique swine VS-NJ viral isolates. However, only 1 of 3 bovine origin isolates produced secondary vesicular lesions in swine. These observations in combination with our findings may provide an explanation for the lack of spread of VS to susceptible swine in the 1982 outbreak. Other factors could be the marked changes in swine production since the mid 1950's when NJ-VS was active in the southeastern United States.
states. Instead of intermingling swine and cattle on the same premises, most producers have converted to the more intensive, labor-saving methods of swine rearing in which pigs are frequently reared in total confinement or modified open front housing. Although replacement gilts and nonpregnant sows are frequently maintained in open pens or on pasture, cattle are not usually intermingled with them. However, the lack of spread of VS to meandering swine in Mexico would also tend to support the clinical observation in this study that bovine origin VS-NJ may be less infective for swine.

**Lesion Threshold:**

The development of vesicular lesions was dose-dependent. Only 1 of the 2 pigs inoculated with $10^4$ TCID$_{50}$ of VS-NJ/Ossabaw/1983 virus developed lesions. This moderately high virus dose-lesion relationship supports a hypothesis of personnel of the Southeastern Cooperative Wildlife Disease Study$^c$ that most seropositive juvenile feral swine observed on Ossabaw Island do not develop vesicular lesions. Only 2 of 44 juvenile feral swine that developed antibodies to VS-NJ (of 300 juveniles trapped) during the spring and summer of 1983 had vesicular lesions. Considering the brief duration of vesicular lesions and how rapidly they heal, many of those pigs could have developed vesicles between trappings, but no residual lesions were observed in 42 pigs. Earlier studies by Shahan, et al$^4$ have demonstrated that contact transmission of clinical and inapparent VS-NJ can readily occur in swine. From this limited study of the 1983 Ossabaw VS-NJ viral isolate in pigs, and previous studies,$^3,4$ it appears that porcine-derived VS-NJ virus circulating within a swine population would be transmissible by contact spread.

Reichmann, et al$^5$ conducted nucleic acid hybridization assays on the 1952 Hazelhurst, Georgia, and the 1943 Kansas City, Missouri, swine isolates and found that those 2 isolates comprised one distinct subtype of VS-NJ virus and that bovine and equine isolates comprised a second subtype. The results of this report may indicate a correlation with those findings. Nucleic acid hybridization assays will be conducted on the 2 isolates, VS-NJ/Durango/1982 and VS-NJ/Ossabaw/1983, evaluated in these studies.$^d$

**REFERENCES**


$^c$ V. F. Nettles, College of Veterinary Medicine, University of Georgia, Athens. Personal Communication. 1983.

$^d$ M. E. Reichmann, Department of Veterinary Microbiology, University of Illinois, Urbana. Personal Communication. 1983.


Figure 1. Serologic response of pigs to varying doses (median tissue culture infective dose/TCID₅₀) of VS-NJ/Durango/1982 virus.
Figure 2. Temperature response of pigs exposed to varying doses (median tissue culture infective dose/TCID<sub>50</sub>) of VS-NJ/Ossabaw/1983 virus, and the appearance of vesicular lesions (●). Post-inoculation day (PID) 0 temperature constructed from the mean temperature of the 13 study pigs at PID 8.

Figure 3. Mean serologic response of pigs to varying doses (median tissue culture infective dose/TCID<sub>50</sub>) of VS-NJ/Ossbaw/1983 virus.
REPORT OF THE COMMITTEE ON TRANSMISSIBLE DISEASES OF SWINE

Chairman: J. P. Kluge, Ames, IA
Vice Chairman: D. G. Thawley, Columbia, MD

L. G. Biehl, IL; Neal Black, MN; C. E. Boyd, SC; John Brown, GA; Jesus Castaneda, Venezuela; R. A. Crandell, TX; A. M. Creswell, TN; P. B. Doby, IL; Gene Erickson, IA; D. P. Gustafson, IN; E. O. Haelterman, IN; R. E. Hall, WI; D. L. Harris, IA; G. W. Hausman, IA; H. T. Hill, IA; R. E. Horton, NJ; C. L. Kanitz, IN; M. H. Lang, IA; Norman Lichtman, NJ; Vincent Marshall, NE; J. W. McVicar, NY; K. E. Myers, IA; P. A. O’Berry, IA; Carson Rogers, NE; Linda Schlater, IA; G. M. Schloer, NY; L. W. Schnurrenberger, MD; J. E. Slauter, MO; W. C. Stewart, IA; Dennis L. Thompson, CA; R. E. Thompson, AR; H. W. Towers, DE; C. D. Van Houweling, VA; J. D. Villari, NJ; B. D. Ward, NY; Fred Wertman, IA

The Transmissible Diseases of Swine Committee was convened at 1:30 p.m. October 19, 1983. Seventeen committee members and 31 guests were present. Five papers were presented.

Dr. L. G. Morehouse presented an overview of the objectives and progress of the North Central Region Enteric Diseases of Swine Project. He noted that enteric diseases have become an increasing problem in swine as management has tended toward increased confinement. To address this problem the NCR project is directed toward the following diseases: transmissible gastroenteritis; rotoviral disease; colibacillosis, swine dysentery; salmonellosis; porcine proliferative enteritis and newly recognized enteropathogens.

Dr. G. A. Erickson gave an overview of vesicular stomatitis. He presented details of the 1982–83 outbreak in the United States with evidence which supports the existence of separate bovine and porcine specific strains of New Jersey VSV. Under natural conditions it appears that inter species transfer between cattle and swine in not common and this could account for the lack of swine infection during the recent outbreak.

Dr. L. J. Hoffman presented a review and update of Hemophilus pleuropneumonia infection. She discussed the emergence and recognition of this disease in recent years together with an outline of current serological techniques and the prevalence and significance of antibody titers in U.S. swine. Current treatment prevention and control techniques were presented. The need for extensive future investigations into the epidemiology, pathogenesis, immunology and diagnostic methods was discussed. The present lack of epidemiological knowledge together with poor understanding of the pathogenesis of the disease combined with the inability to effectively perform challenge studies have hindered the development of effective control measures.

Dr. H. S. Joo reviewed current knowledge on the epidemiology, pathogenesis and prophylaxis of swine parvovirus infection. He discussed the
problems posed by persistence of passive immunity in replacement gilts and the efficacy of vaccination regimes in these animals.

Dr. L. W. Hinchman presented a report of the Pseudorabies Committee meeting.

In committee session a motion was presented by Dr. M. H. Lang to adopt a position paper on the use of in-practice diagnostic aids forwarded by the American Association of Swine Practitioners and the Iowa Veterinary Medical Association. After considerable discussion the motion was tabled for further review and modification by the presenting organizations.

The committee session was adjourned at 5:30 p.m.

Respectively submitted,
J. P. Kluge, Chairman
D. W. Thawley, Vice Chairman
COMPARISON OF ELISA REACTIONS AND TUBERCULIN SKIN RESPONSES IN ELK (CERVUS ELAPHUS) IN A HERD IN WHICH MYCOBACTERIUM BOVIS WAS PREVIOUSLY DIAGNOSED.

Katherine E. Swartz; Charles O. Thoen, D.V.M., Ph.D.; Charles D. Stumpff, D.V.M.; Michael R. Hall, Ph.D. and Elmer M. Himes, D.V.M.

SUMMARY

A modified enzyme-linked immunosorbent assay (ELISA) was developed for detecting mycobacterial antibodies in the serum of elk from a herd in which Mycobacterium bovis was previously diagnosed. The ELISA was conducted on 89 sera using a Triton X-100 antigen extracted from M. bovis strain 19210. The Triton X-100 antigen extract was diluted 1:300 in a 0.1 M Na2CO3 buffer containing carbodiimide; the plates were incubated overnight at 4°C and subsequently treated with 0.1 M NH4Cl for 30 minutes. Affinity-purified goat anti-bovine IgG (H+L) labeled with horseradish peroxidase was used as the conjugate at a 1:600 dilution. Sera of 17 of 20 elk positive on the tuberculin skin test had positive ELISA reactions; serum of 1 animal was classified as suspect on ELISA and sera of 2 were negative. The two elk negative on ELISA had tuberculin skin test responses of 4mm and 9mm respectively and the suspect elk had a 4mm response on the tuberculin skin test.

INTRODUCTION

Tuberculosis in wild ruminants in the United States has been widely documented. Diagnosis is usually made on isolation and identification of the acid-fast organism; this usually requires 6–12 weeks. Serologic methods of detecting infected or exposed animals have not been available. However, a rapid, reliable in vitro test for screening animals captured in the wild or confined in zoos and game parks could be of value in the diagnosis of tuberculosis in wild animals.

This investigation was conducted to evaluate a modified ELISA which was previously used for detecting mycobacterial antibodies in sera of cattle from which M. paratuberculosis was isolated. The objectives were: 1) to evaluate a modified ELISA for detecting antibodies in sera from elk in a herd in which M. bovis was previously diagnosed, 2) to compare in vitro ELISA reactions and tuberculin skin test responses and 3) to obtain information on the use of a Triton X-100 extract of M. bovis strain 19210 in the modified ELISA.

From the Department of Veterinary Microbiology and Preventive Medicine, College of Veterinary Medicine, Iowa State University, Ames, IA (Swartz, Thoen and Hall), Veterinary Services, APHIS, U.S. Dept. of Agriculture, Topeka, KS (Stumpff) and Pathobiology Laboratory, National Veterinary Services Labs, Veterinary Services, APHIS, U.S. Dept. of Agriculture, Ames, IA (Himes).
MATERIALS AND METHODS

Sera of 116 elk were obtained from three herds. This included sera from 53 elk from a herd in which *M. bovis* was previously diagnosed and sera from 63 elk in two non-infected herds, (Herd 1 = 33 elk and Herd 2 = 30 elk) were used.

**ELISA antigen.** A Triton X-100 antigen extract of *M. bovis* strain 19210 was prepared according to procedure previously described. Three antigen dilutions of 1:100, 1:300 and 1:600 were tested with sera from tuberculous cattle and non-infected cattle, along with serum from elk found positive and negative on the tuberculin skin test at 72 hours post-injection with *M. bovis* PPD. The 1:300 antigen dilution was selected as the optimal dilution.

**Conjugate.** Affinity purified goat antibovine IgG (H + L) labeled with horseradish peroxidase was obtained commercially (CM10-1).*

**Substrate.** A working solution of substrate was prepared using H$_2$O$_2$ and 2-2’ azinodi-(3 ethyl benthiozaline-6-sulfonate) in citric acid.

**ELISA procedure.** The ELISA was conducted by modification of procedures previously described. A Triton extract of *M. bovis* strain 19210 was diluted in 0.1 M Na$_2$CO$_3$ (pH 9.6); 50 μl of the antigen preparation (1:300 dilution) and 100 μl of a carbodiimide solution were added to wells of Gilford cuvettes. The cuvettes were incubated in a sealed container at 4°C for 16 hours and washed three times with phosphate buffered saline solution (PBS), (ph 7.4). One hundred μl of 0.1 M NH$_4$Cl was added to each well and allowed to incubate at 22°C for 30 minutes. The cuvettes were then washed one time with PBS. Serum samples from each of the 89 elk were diluted 1:10; serial dilutions were made from 1:20 to 15120 in 0.5 M NaCl containing 1% Tween 80 and adjusted to pH 7.5 with 1 M K$_2$HPO$_4$ (diluent solution). The sera were incubated for 30 minutes at 22°C on a horizontal shaker.** The wells were washed 8 times with 0.5 M NaCl solution containing 0.5% Tween 80 (pH 7.5) and inverted for 10 minutes to remove excess wash solution. Next, 50 μl of a 1:600 dilution of affinity purified goat anti-bovine IgG (Lot# CM10-1) was added to each well. The plates were incubated again for 30 minutes at 22°C on a horizontal shaker, washed 8 times, and allowed to drain for 30 minutes. One hundred μl of a substrate solution (ABTS + H$_2$O$_2$ in citric acid) was added to each well and incubated for 4 hours at 22°C.** After 4 hours, 200 μl of deionized water was dispensed into each well. A Gilford PR-50 Processor-Reader was used to obtain quantitative results on the color intensity of the ELISA reactions at a wavelength of 405 nm.

RESULTS

Results of ELISA conducted on sera of 26 elk from a herd in which *Mycobacterium bovis* was diagnosed are shown in Table 1. Sera of 17 of 20 elk positive on the tuberculin skin test (4 mm or greater response) had

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*Kirkegaard and Perry, Gaithersburg, MD.
positive ELISA reactions at a 1:80 serum dilution; 2 sera were negative on ELISA and 1 was classified as suspect. The two elk negative on ELISA had tuberculin skin test responses of 4mm and 9mm respectively, whereas the suspect elk had a 4mm response on the tuberculin skin test. Six elk had minimal tuberculin skin test responses (1-4mm). Four of these animals were positive on ELISA and 2 were negative. The tuberculin skin test responses of the elk negative on ELISA were 1.5mm and 2.5mm respectively. ELISA reactions were observed in sera of 7 of 27 elk negative on tuberculin skin test.

The mean values of the ELISA results of elk grouped together according to tuberculin skin test responses are shown in Figure 1. Mean ELISA values for serum dilutions of 1:20 to 1:320 of 26 elk positive on the tuberculin skin test and of 63 elk in two herds negative on tuberculin test are shown. Important differences were observed on ELISA reactions in sera of elk positive on tuberculin test as compared to results obtained on controls.

ELISA reactions observed in the sera of 6 elk with positive tuberculin skin tests are shown in Figure 2. ELISA reactions observed in sera of elk with tuberculin skin test responses of 8 mm or greater varied considerably. Elk no. 25 and elk no. 33 each had tuberculin skin test responses of 14 mm; yet elk no. 25 had an ELISA reaction 2 times greater than the ELISA reaction observed in sera of elk no. 33. Similarly, elk no. 19 and elk no. 26 showed moderate tuberculin skin test responses of 10 mm and 8 mm respectively; however, both elk had ELISA reactions greater than the ELISA reaction observed in sera of elk no. 25. Thus, no correlation could be made between the magnitude of the ELISA reaction and the tuberculin skin test responses observed in elk.

DISCUSSION

Mycobacterium bovis infections have been reported in several wild animals. However, the use of serologic tests in the diagnosis of mycobacterial infections has been limited because of nonspecific reactions and false-negative results. Development of a rapid, reliable in vitro test could provide for the removal of infected animals from the population thereby minimizing the spread of tuberculosis to other animals. The ELISA test described herein has an important advantage in that wild animals only need to be handled once to collect blood, whereas animals which are tuberculin skin tested must be restrained twice.

The modified ELISA reported herein provided for the detection of antibodies in the sera of 17 of 20 elk that had reacted on tuberculin skin tests. Further studies are needed comparing ELISA reactions with mycobacteriologic results in animals suspected of being tuberculous.
Figure 1. Comparison of ELISA reactions (mean value) for each of 3 groups of elk responding on tuberculin skin test and 2 control groups.
Figure 2. Comparison of ELISA reactions in sera from 6 elk responding on tuberculin skin test and ELISA reaction for controls (mean value).
REFERENCES


Table 1:

COMPARISON OF ELISA REACTIONS AND TUBERCULIN SKIN TEST RESPONSES IN ELK IN A HERD IN WHICH M. BOVIS WAS DIAGNOSED.

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<thead>
<tr>
<th>ELISA Reactions*</th>
<th>Tuberculin Skin Test Response (mm)</th>
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<tr>
<td></td>
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<td>Positive **</td>
<td>4</td>
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<tr>
<td>Total# Animals</td>
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</table>

* Serum Dilution 1:80

** Positive = 2x the ELISA value for pool of negative sera from 63 elk.

= 2 sera negative on ELISA had tuberculin skin test responses of 2.5 mm and 1.5 mm (#13, #48)

+ Sera negative on ELISA had a tuberculin skin response of 4 mm (#11). Suspect serum on ELISA had a tuberculin skin test response of 6 mm (#27).

o Negative serum on ELISA had a 9 mm tuberculin skin test response (#28). 63 negative animals at 1:80 dilution - average 0.120 response on ELISA.
ISOLATION OF MYCOBACTERIA FROM CALIFORNIA SLAUGHTER SWINE

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SUMMARY

In samples collected from California slaughter swine, 99 isolates of bacteria of the Mycobacterium avium-complex were isolated from 196 lymph nodes with grossly visible lesions declared to be mycobacteriosis (tuberculosis) by inspectors. The most commonly isolated serotypes of M. avium from lymph nodes with lesions were serotypes 4 and 8. Isolations were also made of 6.4% of 280 grossly normal nodes, not only from animals originating from 2 ranches which formerly had high rates of slaughter determinations of mycobacteriosis, but also from animals from ranches which had not had such problems.

INTRODUCTION

Slaughter swine carcasses with lesions compatible with mycobacteriosis ("tuberculosis") are subject to trimming, cooking or condemnation (4), resulting in financial loss to the producer (1). The annual loss to the US swine industry has been estimated to be over ten million dollars (3). Several California swine producers have experienced severe losses at slaughter inspection in the recent past (6).

In this study, California-raised slaughter swine with and without grossly visible lymph node lesions declared to be mycobacteriosis by inspectors were monitored for the presence of Mycobacterium avium-complex bacteria. Some of the nodes without grossly visible lesions were from animals from ranches which formerly had high rates of mycobacteriosis at slaughter. For these ranches we wished to determine whether cessation of the outbreaks was accompanied by inability to isolate M. avium-complex from grossly normal lymph nodes. We report the attempts to isolate M. avium-complex bacteria from 196 nodes with grossly visible lesions compatible with mycobacteriosis, and 280 nodes without visible lesions.

MATERIALS AND METHODS

Nodes with grossly visible lesions

The monitoring program extended from December 1980 through June 1983. From December 1980 through February 1982 (sampling period 1), abattoir managers were requested to retain under refrigeration one le-
lesioned lymph node from each California-raised swine carcass passed for cooking (due to lesions declared to be mycobacteriosis in two or more sites (4)). In the second sampling period from March 1982 through June 1983, managers were requested to save one lesioned node from each California carcass in which lesions were found in any site. One to three days after collection, the samples were transported on ice to the laboratory where isolation of mycobacteria was performed by standard methods (17) using Herrold's media with and without mycobactin. Impression smears of each node were stained by the Ziehl-Neelsen technique to determine the presence of acid fast bacilli before culture. After 8 weeks of incubation, colonies were stained by the Ziehl-Neelsen method and acid-fast isolates were sent to the National Veterinary Services Laboratory (NVSL) for confirmation as *M. avium*-complex and serotyping.

Two isolates, one reported as serotype 1 and the other as serotype 2 by NVSL, were grown on Herrold's medium and a saline suspension of harvested colonies of each type was inoculated intravenously into a 20-week old chicken. The birds were necropsied 8 weeks after inoculation.

**Nodes without grossly visible lesions**

During the summer of 1982, mesenteric lymph nodes from animals with no lesions at slaughter were collected as previously described (9), transported on ice to the laboratory and processed 6–8 hours after collection. All ranches of origin but one were modern farrow to finish operations ranging in size from approximately 100 to 600 sows; the other ranch was a garbage feeding operation which purchased feeder pigs. Ranches No. 1 and 3 were chosen for sampling because in the past they had had many animals passed for cooking due to inspectors' determinations of mycobacteriosis but had few or no animals passed for cooking for the year prior to the sampling reported here. The other 7 ranches had never had these problems. All farrow to finish ranches except No. 15 used wood shavings in farrowing crates. In the laboratory, isolation of mycobacteria was performed by standard methods (17) as previously described (9). Acid-fast bacterial isolates were sent to NVSL for confirmation as *M. avium*-complex and serotyping.

**RESULTS**

**Nodes with grossly visible lesions**

Results were available from 196 lesioned nodes submitted to the laboratory (Table 1). Ninety-nine isolates of *Mycobacterium avium*-complex bacteria were recovered from 96 (49%) of the 196 nodes (3 nodes contained 2 distinct colony types). In 17 of these 96 culture-positive nodes, acid-fast bacteria were not observed in the impression smear made prior to culture. Mycobacteria were not isolated from 100 nodes; in 11 of these nodes acid-fast bacteria had been observed in the impression smear made prior to culture. In the first sampling period (nodes from animals with lesions in 2 different sites), *M. avium*-complex bacteria were isolated from 36 (63%) of the 57 nodes submitted. In the second sampling period (nodes from animals...
with lesions in either 1 or 2 sites), *M. avium* was isolated from 60 (43%) of 139 nodes submitted. The difference in the 2 isolation rates was statistically significant (P < 0.05). For the 2 sampling periods combined, serotypes 4 and 8 were the most commonly isolated, representing 24% and 20%, respectively, of the total isolations. There was no apparent difference in proportions of serotypes isolated in the 2 sampling periods.

At necropsy of chickens inoculated with suspensions of *M. avium* serotypes 1 and 2, acid-fast bacteria were recovered from white foci in the livers and spleens of both birds.

**Nodes without grossly visible lesions**

Bacteria of the *M. avium*-complex were recovered from 6.7% of 280 mesenteric lymph nodes from 280 animals (Table 2). Isolation rates of 5% and 30% were made from animals from the 2 ranches which formerly had many animals with lesions at slaughter. Isolations were also made from animals from 3 of 7 ranches which had not experienced problems.

**DISCUSSION**

In the past, for the United States as a whole (14), and in certain sections of the United States (8), as well as the 11 western continental United States (14), the most common serotypes of *M. avium*-complex bacteria isolated from lymph nodes of slaughter swine were serotypes 1 and 2; this was also true in other countries such as Germany (7) and Czechoslovakia (5). More recently, *M. avium*-complex serotypes 4 and 8 have been increasingly isolated in the United States (16) and in other countries of the world including Japan (18), South Africa (10) and Norway (12). This latter pattern, associated by some research workers with large confinement swine herds (16), is the isolation pattern observed in the California lymph node lesions described in this paper. In reported outbreaks of swine mycobacteriosis, it is common for many serotypes to be isolated from the same ranch outbreak (11, 13). In this study, many serotypes of *M. avium*-complex bacteria were isolated from nodes with grossly visible lesions from individual ranches over the time of the study.

There is little information regarding the origin and transmission of *M. avium*-complex serotypes 4 (16) and 8 (15). The origin of *M. avium* serotypes 1 and 2 in this study is not known; tuberculosis has not been reported in California commercial chickens for several decades (Personal communication; P. Smith, Chief, California Bureau of Animal Health).

The overall percentage of lesioned nodes culture-positive for *M. avium*-complex, 49%, was less than the 80% isolation rate reported previously from the western region (14). The isolation rate was higher in the first sampling period (nodes from animals with lesions in 2 sites) than in the second sampling period (nodes from animals with lesions in 1 or 2 sites). This could indicate that inspectors’ determinations of mycobacteriosis were more accurate when lesions were found in more than one site, or that lower numbers of bacteria were present in nodes of animals with lesions in only one site. Other explanations are also possible,
but caution should be exercised in interpretation because the two types of isolations were not performed during the same time period.

*Mycobacterium avium*-complex bacteria have been recovered previously from porcine lymph nodes with no grossly visible lesions (2). An interesting aspect of the present study was isolation of *M. avium*-complex from swine on two ranches (Nos. 1 and 3) which in swine slaughtered during 1980–81 had high rates of lymph node lesions declared by inspectors to be of mycobacteriosis (6). Animals from these ranches were subsequently apparently free of the disease, as judged by the absence of lesions at slaughter. Seventeen per cent of the animals sampled from ranch No. 21 were culture-positive for *M. avium*-complex, yet this ranch did not have lesions identified at slaughter 1980–1983. Both of these situations add credence to previous suggestions (15) that the presence of *M. avium*-complex bacteria may be a necessary but not sufficient condition for the development of *M. avium*-complex lymph node lesions at slaughter. Other factors, yet to be identified, may act in concert with bacteria to produce lesions and the resultant financial loss to the producer.

ACKNOWLEDGMENTS

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The authors thank Dr. P. Smith for advice, Drs. J. Nehay, R. Ziriax and others for assistance in sample collection, personnel of the Food Safety Inspection Service, Meat and Poultry Inspection, USDA and managers of the abattoirs for their cooperation, J. Morse and S. Ernst for technical assistance, and the National Veterinary Services Laboratory, Ames, Iowa for identification and serotyping of the isolates.

REFERENCES


Table 1. Serotypes of *Mycobacterium avium* complex bacteria isolated from 99 lymph nodes with lesions compatible with mycobacteriosis, collected from California slaughter swine.

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TOTAL 10 3 24 2 6 1 20 2 5 4 1 4 1 16 99

*Double serotype*
Table 2. Serotypes of *Mycobacterium avium*-complex bacteria isolated from 280 mesenteric lymph nodes with no visible lesions from California slaughter swine.

<table>
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<td>17</td>
<td>0</td>
</tr>
<tr>
<td>22</td>
<td>40</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>280</td>
<td>6.4</td>
<td>1</td>
</tr>
</tbody>
</table>

*Double serotype
bCorresponds to ranch of same number in Table 1.
On January 14, 1983, 1 6-35 case was reported compatible from a submission from Pioneer Beef Company, Grenada, Mississippi. The lesioned animal was identified by an ear tag only, 64AJS9271. The preliminary investigation by the Mississippi office revealed that the subject animal probably originated from a dairy herd in northern Mississippi. This is a quarantined herd for Brucellosis. The animal apparently left his herd hereafter referred to as Herd L on a VS 1-27 erroneously identified as 54AJS9451 to the South Memphis Stockyards. On the VS 1-27 from Memphis, part of the error was corrected (54 to 64), however, the same number 9451 was marked over the apparent correct reading of 9271. In spite of these problems, Dr. Thomas and perhaps others, by careful analysis of the consignors of the lot of 12, and other data, concluded that the animal most likely belongs to herd L, Red Banks, Mississippi, with the correct identification number of 64AJS9271. They deserve special commendation for their work.

Herd L, Red Banks, Mississippi, consists of 1000 head of dairy cattle of all ages. In addition to milking about 800 cows, they process their own milk and buy milk from other sources. The farm is a family affair operated by the father and two sons. This dairy was established after World War II and through the years gradually increased in size.

On February 3 and 4, 1983, 785 cattle were tested by the caudal fold route. Two hundred and sixty-seven responses were recorded. Comparative cervical tests were performed on 80 of the reactors. Eleven animals were in the reactor zone and nineteen animals were in the suspect zone. Both the suspect and reactors were classified reactors based on tuberculin responses and herd history.

In addition, five other caudal fold responding animals were classified as reactors. This total of 35 TB reactors were slaughtered at Bryan Packing Company, West Point, Mississippi, on February 17, 1983. Seventeen animals had gross lesions of TB. Samples from all 35 animals were submitted to NVSL. Lesions from 16 animals were classified as compatible for tuberculosis. One hundred eighteen additional animals on a second farm owned by Herd L were tested February 17, 1983. Eight animals were responders on the caudal fold test. All responding animals to any of the tests were classified as reactors. Two hundred thirty-one reactors were slaughtered at Palestine, Texas, with 35 additional gross lesion cases reported. M. bovis was isolated from the original 6-35 animal. Depopulation of balance of the herd was recommended and subsequent approval was obtained.

Herd depopulation was completed March 24, 1983. A total of 1019 animals have been slaughtered. One hundred and twenty-eight animals had gross lesions and fourteen were condemned. Some of the con-
demnations were due to other pathological conditions than Tuberculosis.

Herd L presented complex epidemiology problems. Some preliminary observations are as follows:

1. It would appear that Tuberculosis was introduced sometime during the past three years. This is only a rough estimate and does not eliminate introduction of the infection before this time frame.

2. During the past three years no adult animals have been sold except cull animals. All calves both females and males were sold the first year of the three year period. During the past two years bull calves only were sold. Complete records of these sales are not available. It will be necessary to investigate all such calf sales. A few years ago a number of infected herds were located by such tracing in Puerto Rico.

3. The most critical phase of epidemiology of this herd was the effect made in location of the source herds. This effort was handicapped by incomplete herd records, lack of identification on purchased animals, size of herds, multiple purchases of additions involving several states, nature of the disease, and part of the herd being composed of leased cattle.

A review of the records of the herd owner of Herd L indicated a total number of at least fifteen different source herds.

Eight such herds were located in the State of Mississippi including the herd of origin of the 6-35 animals. One of the source herds was a dealer who purchased animals from multiple sources with no animals to test. Another dealer had a herd that was tested negative but sold random purchased cattle. The animals purchased from this dealer were in a group of cattle leased from a leasing corporation in Tennessee. This group of animals entered Herd L about 60 days prior to disclosure of the infection. All Mississippi herds were negative to the tuberculin test. Four herds were located in Tennessee. All herds were tuberculin negative. One herd was located in Missouri and was negative to the tuberculin test. Two herds (part of the leased cattle) were in Kentucky. Both of these were dealer type operations. One of the dealer's maintained a parent herd and was tuberculin negative. One dealer was out of business and had left the state. All of these cattle were obtained from many sources and sales. Tracing in general was not possible.

Indiana, Louisiana, and Alabama were implicated by ear-tag numbers only. Most moved through dealer channels and effort to locate the original herds were not successful.

About 250 animals were owned by a leasing corporation operating out of Tennessee. The original sources of the leased cattle were two dealers in Kentucky and one in Mississippi. The Kentucky groups entered the herd in January and February of 1982. The herds of origin of cattle from these two dealers cannot be determined. The Mississippi dealer's cattle herd had been in the herd for about 60 days and was not seriously considered a source of the outbreak.
There was a rapid turnover of cows in this dairy. The owner often bought entire herds or most of such herds. The time frame of entrance of *M. Bovis* in this herd is a matter of speculation. There is evidence that the herd has recently become infected. Factors considered in this conclusion were:

1. Calves 3–6 months of age had a high response pattern and gross lesions were observed at a rate higher than one would expect. Animals 1–2 years of age had a low response rate and a low lesion rate.
2. Gross lesions in the adult herd were not extensive except in a few animals.
3. Animals were housed in close confinement under conditions lending itself to rapid spread.

Location of the source of infection was not determined. The introduction by the leased cattle in 1982 remains as one of the possibilities. The possibility of introduction prior to 1980 from an unknown source must be considered.

Sales from Herd L in general were limited to young calves. In a few instances older bulls were sold. Most sales were cash transactions, and in most instances no records were completed. Information as to sales were obtained from the owners memory and what records were available.

Twenty-six herds were located in Mississippi. Fifty animals from Herd L were slaughtered as exposed—herds were negative. An exposed animal in one herd had gross lesions of tuberculosis and was suggestive on histopathology. A herd test yielded 9R and 5N on cattle. Four of five goats also reacted to the test.

Five herds were located in Tennessee—One herd had one animal with gross lesions—Herd was depopulated.

Two traces were referred to Arkansas—no report at this time.

Two traces were reported to Oklahoma—no report at this time.

One herd was located in Kentucky and was tuberculin negative.

It is obvious that only a small number of animals where tracing was successful. No doubt that several hundred animals left this herd that could not be traced. This is important because seeds of future outbreaks may have been planted. It is also interesting to note that young calves left this herd that were infected and was responsible for two infected herds of 36 herds traced.

In addition, all neighboring herds of herd L were tested. Some of these herds were fence-line exposed. Other herds, co-mingling of animals occurred. Eleven such herds were located and tested.

In past TB outbreaks in such herds, invariably two common denominators are evident.

1. A large number of animals have been culled for slaughter with no lesions reported. Herd L is no exception. The herd has apparently been infected for 1–3 years minimum. One hundred and twenty-five cows have been culled from the herd during the past year. One
hundred twenty-eight lesioned cases were disclosed on depopulation indicating 12% lesion rate.

Probably 12–15 lesioned animals existed in the 125 cull cows sold. Only one lesioned case was reported during this time and it was an advanced case.

Based on personal observation of 35 reactors slaughtered most had comparative small lesions involving one or two nodes. Such lesions could have easily been overlooked or judged to something other than TB. This emphasizes the need of continuous and increased contact with Meat Inspection personnel by Veterinary Services. The final date of eradication of TB would be advanced by the universal reporting of all thoracid granulomas and other suspicious lesions of TB by Meat Inspection personnel. Special emphasis should be given to cow kill plants.

2. The herd has had a recent negative TB test. The L herd had a negative herd test of 400 animals three years ago. It is difficult to test 400 confined dairy cows without some responses reported on the caudal fold test. I have reservations about the quality of test procedures when no responses are reported on a test of a herd of this size maintained in close confinement. It is no secret that an alarming number of tests performed by veterinarians are of little value. There is a continuous need for acquainting practicing veterinarians and regulatory veterinarians of tuberculosis testing techniques and the importance of reporting of all responses to a tuberculin test.

The Mississippi State Health Department conducted tuberculin tests on 25 persons employed or associated with this dairy. Eight persons were considered positive to the skin test. One person had lung lesions on chest x-ray and M. Bovis was isolated from bronchial washings. This party was a milker in this operation and spent a lot of time in the dairy barn. The mode of possible transmission from cattle is an interesting consideration. Milk was consumed from the dairy but was pasteurized. Transmission was likely through droplet inhalation. A high percentage of lesions were located in the respiratory tract of the cattle.
EXPERIMENTAL EXPOSURE OF CATTLE TO MYCOBACTERIUM PARATUBERCULOSIS ORALLY AND INTRAUTERINE WITH ATTEMPTED CULTURE OF THE ORGANISM AND DETECTION OF HUMORAL ANTIBODIES

Dr. Wm. J. Owen
I.S.U., Veterinary Clinical Sciences
Dr. Charles O. Thoen
I.S.U., Veterinary Microbiology and Preventive Medicine

INTRODUCTION

Vertical transmission of M. Paratuberculosis has been determined a distinct possibility in previous studies. Attempts at eradication of M. paratuberculosis has been accelerated with the removal of offspring of known infected cows. Reproductive problems in herds with M. paratuberculosis infection has been reported.

Eradication of M. paratuberculosis is difficult because of lack of reliable tests. Humoral antibodies to M. paratuberculosis after infection are either slow appearing, absent, or are not being detected by our present testing techniques. Fecal culturing indicates intermittent shedding or failure of culturing the organism if it is present in the feces.

The objectives of this study were:

1. A comparison of two possible routes of infection by M. paratuberculosis, oral and intrauterine.

2. Evaluate detection of humoral antibodies for M. paratuberculosis, ELISA and Intravenous Johnin test.

MATERIALS AND METHODS

Six Jersey heifers, approximately one year old were purchased from one farm. The heifers were housed in a common three acre lot with a polled shed for protection. Water was supplied by an automatic fountain. Feed consisted of large round bales enclosed in a bar type bale container and grain was placed in rubberized containers at ground level.

Two fecal and blood samples were taken at 30 day intervals from each of the heifers before exposure to M. paratuberculosis. Heifers 334, 337 and 349 were inseminated during estrus with semen contaminated with 300 mg, 200 mg and 400 mg (wetweight) of M. paratuberculosis cult respectively. Heifers 335, 336 and 348 were each exposed orally to 400 mg of M. paratuberculosis culture, half of which was given by gelatin capsule and half was deposited in the pharyngeal area. The M. paratuberculosis used in the culture was isolated from a cow in Iowa with clinical signs of Johne's disease. The heifers were estrous synchronized by using Lutalyse.

Fecal samples and blood were collected at thirty day intervals from each

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* Lutalyse (dinoprost tromethamine) product Upjohn Co.
DETECTION OF HUMORAL ANTIBODIES

Heifer after exposure to *M. paratuberculosis* for a period of 28 months.

Laparotomys were performed on each heifer to obtain lymph nodes from the ileo-cecal valve area at the 16th month postexposure.

Cesarean sections were performed the second gestation on heifers 349, 334 (oral exposure) and 335 (intrauterine exposure) in the 23rd and 24th month postexposure. The three calves were removed aseptically and penned together at a different location. Heifers 348 and 336 (oral exposure) calved normally in the lot and their calves remained with their mothers. Placental tissues and blood from the cesarean section calves were collected for culture and testing. Blood and feces were collected from all calves at 30 day intervals after delivery.

The Intravenous Johnin test was conducted on all cattle on the 28th month postexposure. An individual dose of three ml of Johnin\(^b\) per animal was used.

**RESULTS**

All heifers were exposed to *M. paratuberculosis* within a two day period at the time of first artificial insemination. The breeding dates and pregnancy determination are shown in table one. Heifer 337, the only heifer determined pregnant at 60 days, aborted the eighth month of pregnancy. *M. paratuberculosis* was isolated from the liver, spleen, mesenteric lymph nodes and intestines of the fetus.

The heifers were exposed for 60 days to a bull for the second gestation period. The pregnancy status of the heifers for this period is shown in table two. Heifer 337 aborted between the 60th and 120th day of pregnancy. The fetus and tissues were not available for culture examination.

Tables three and four are a compilation of the test results for each heifer. Each column represents a thirty day period. Column one represents initial exposure. Column 14 is missing as material was not collected during that period. The row indicating the lymph nodes culture results appears once as only one laparotomy was performed to obtain a node from the ileo-cecal area. The same for the fetal tissues and the Intravenous Johnin test.

Blood and feces were obtained from the five calves at 30 day intervals. Calf 334 C, delivered by cesarean section from cow 334, showed a reaction to ELISA on the day of delivery. Final results of the fecal culture, and blood are not yet available.

Colostrum, placenta, cotolydones and amniotic fluid were collected from each cow, 334, 335 and 349 during the cesarean section. Result are not yet available.

The amount of Johnin (3 ml) given intravenous to each animal was the same. This amount probably should have been reduced for the calves. Calves 336 C and 348 C had a severe anaphylactic reaction two hours after inoculation. Both calves developed diarrhea and dyspnea. This reaction lasted for three hours and may have affected their temperature response.

\(^b\) Test material obtained from Dr. Merkal, N.A.D.C., Ames, Iowa.
Interpretation of the Intravenous Johnin test would indicate that all three heifers exposed to *M. paratuberculosis* intrauterine, 334, 337, 349, were positive (fig. 1). One heifer, 335, exposed orally was positive while one heifer exposed orally was negative (fig. 2). Heifer 336 had an elevation of two degrees but it did not occur until the 6th hour and she was called a suspect.

The calves remaining with the heifers, 336 C and 348 C were negative to the Intravenous Johnin test (fig. 3). The severe anaphylactic reaction to Johnin has been discussed.

Two calves, 334 C and 349 C delivered by cesarean section and raised away from their dams were positive to the Intravenous Johnin test (fig. 4). The third calf, 335 C, gradually became debilitated and was euthanized at eight weeks of age. Culturing of tissues from 335 C is continuing but there is no report at this time.

**DISCUSSION**

This study was hampered by lack of numbers. It is also realized that since the six heifers were housed together that the initial exposure may not have been the actual source of infection. Once shedding occurred in one heifer it would then possibly be the source of infection for the remaining heifers.

*M. paratuberculosis* was cultured from the feces of three of the heifers prior to detection of humoral antibodies by ELISA. Heifer 337 aborted a fetus from which *M. paratuberculosis* was isolated two months prior to showing a reaction to ELISA. One heifer, 348, was negative and one heifer, 336, suspicious to the Johnin test. Both heifers had *M. paratuberculosis* isolation previous to the test. Indications are that detection of humoral antibodies, if present, is still a problem.

Heifer 337, which was infected intrauterine, was the first to have *M. paratuberculosis* cultured from the feces. This was five months postexposure. This heifer subsequently aborted twice with the isolation of the organism from her first fetus. This may indicate the infected semen was the initial source of infection, however the comingling of all six heifers would prevent making a definite determination.

The two calves delivered by cesarean section showed a reaction to the Intravenous Johnin test. Tissues from the calves will be taken to attempt to culture *M. paratuberculosis*. The two living calves, 336 C and 348 C plus the calf that died, 334 C, were housed together after delivery, therefore a possibility of horizontal transmission between the calves existed. There are indications that intrauterine infection of the fetus did occur.

The heifers, 28 months after exposure to *M. paratuberculosis* remain in normal condition except 335. Heifer 335 developed a left displaced abomasum 25 months postexposure and became quite thin.

**ACKNOWLEDGEMENTS**

This project was made possible by a grant from the Iowa Beef Industry
Council.

The ELISA and culture procedures were conducted in Dr. Thoen's laboratory by Wilma Gene Eacret, Camille Ivey, Susan Powell, Kathy Knodel and Tannis Petersburg, Department of Veterinary Microbiology and Preventive Medicine, Iowa State University, Ames, Iowa.

REFERENCES

TABLE 1. Artificial Insemination (AI) dates and pregnancy results of first gestation of heifers experimentally exposed to *M. paratuberculosis*.

<table>
<thead>
<tr>
<th>Heifer Intrauterine exposure</th>
<th>AI Date</th>
<th>AI Date</th>
<th>AI Date</th>
<th>Preg. Exam 7-28-81</th>
</tr>
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<tbody>
<tr>
<td>334</td>
<td>6-2-81</td>
<td>6-20-81</td>
<td>7-9-81</td>
<td>Preg. ?</td>
</tr>
<tr>
<td>337</td>
<td>6-2-81</td>
<td>6-20-81</td>
<td>-</td>
<td>Preg.</td>
</tr>
<tr>
<td>349</td>
<td>6-2-81</td>
<td>6-21-81</td>
<td>-</td>
<td>Open</td>
</tr>
</tbody>
</table>

Oral exposure

| 335                          | 6-4-81  | -        | -       | Open              |
| 336                          | 6-4-81  | -        | -       | Open              |
| 348                          | 6-4-81  | 6-20-81  | -       | Open              |
TABLE 2. Pregnancy examinations and calving dates of second gestation of heifers experimentally exposed to *M. paratuberculosis*

<table>
<thead>
<tr>
<th>Heifer</th>
<th>Intrauterine exposure</th>
<th>9-13-82</th>
<th>1-20-83</th>
<th>3-14-83</th>
<th>Calved or C. section*</th>
</tr>
</thead>
<tbody>
<tr>
<td>337</td>
<td>Preg.</td>
<td>Open</td>
<td>Open</td>
<td></td>
<td>—</td>
</tr>
</tbody>
</table>

**Oral exposure**

| 335    | Preg.                 | Preg.   | Preg.   |         | *5-3-83              |
| 336    | Preg.                 | Preg.   | Preg.   |         | 5-13-83              |
| 348    | Preg.                 | Preg.   | Preg.   |         | 5-11-83              |
TABLE 3. Test results of heifers experimentally infected intrauterine with \textit{M. paratuberculosis} by using contaminated semen. Each column represents 30 days. Exposure was at column one.

| Heifer 334 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Fecal Culture | - | - | - | - | - | - | - | - | - | 0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ELISA | - | - | - | - | - | - | - | - | - | N | 0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Lymph node culture | N |
| Fetal tissue culture | |
| Intravenous Johnin | |

<table>
<thead>
<tr>
<th>Heifer 337</th>
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<tbody>
<tr>
<td>Fecal culture</td>
</tr>
<tr>
<td>ELISA</td>
</tr>
<tr>
<td>Lymph node culture</td>
</tr>
<tr>
<td>Fetal tissue culture</td>
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<tr>
<td>Intravenous Johnin</td>
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</table>

<table>
<thead>
<tr>
<th>Heifer 349</th>
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</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>Lymph node culture</td>
</tr>
<tr>
<td>Fetal tissue culture</td>
</tr>
<tr>
<td>Intravenous Johnin</td>
</tr>
</tbody>
</table>

0 = No data  
- = not reported (Elisa)  
N = negative (-)  
+ = reaction  
P = positive
TABLE 5. Temperature Results (Degrees Fahrenheit) of Intravenous Johnin Test

<table>
<thead>
<tr>
<th>Heifer</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<td>102²</td>
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<td>105⁶</td>
<td>104⁶</td>
<td>103⁴</td>
<td>101⁰</td>
<td>101²</td>
</tr>
<tr>
<td>349</td>
<td>101⁸</td>
<td>102⁸</td>
<td>102⁸</td>
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<td>104⁴</td>
<td>102⁴</td>
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<tr>
<td>335</td>
<td>99⁷</td>
<td>100⁶</td>
<td>102⁰</td>
<td>104⁴</td>
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<td>105⁰</td>
<td>103⁸</td>
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<td>101⁶</td>
<td>101⁶</td>
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<td>101²</td>
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<td>103⁰</td>
<td>103⁰</td>
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<tr>
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<td>102⁴</td>
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<td>101⁶</td>
<td>101³</td>
</tr>
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<td>336C</td>
<td>102⁷</td>
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<td>102⁸</td>
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<tr>
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<td>104²</td>
<td>104⁰</td>
<td>103⁰</td>
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Figure 1. Results of Intravenous Johnin Test of heifers experimentally exposed intrauterine by *M. paratuberculosis*.
Figure 2. Results of Intravenous Johnin Test of heifers experimentally exposed orally by *M. paratuberculosis*.
Figure 3. Results of Intravenous Johnin Test of calves derived by caesarean section and raised separately.
Figure 4. Results of Intravenous Johnin Test of Calves remaining with their dams.
SWINE TUBERCULOSIS: APPLICATION OF A MODIFIED ELISA FOR THE DETECTION OF MYCOBACTERIAL ANTIBODIES IN SERA.

Charles O. Thoen, DVM, Ph.D., Tannis A. Petersburg, B.S., Charles D. Stumpff, DVM, Michael R. Hall, Ph.D. and R. D. Angus, DVM, MPH.

From the Department of Veterinary Microbiology and Preventive Medicine, College of Veterinary Medicine, Iowa State University, Ames, IA (Thoen, Petersburg, Hall); Veterinary Services, APHIS, U.S. Department of Agriculture, Topeka, KS (Stumpff) and National Veterinary Services Laboratories U.S. Department of Agriculture, APHIS, Ames, IA (Angus).

SUMMARY

A modified ELISA was developed for detecting mycobacterial antibodies in the sera of swine experimentally exposed to Mycobacterium bovis or to M. avium complex serotype 8. A potassium chloride extract of M. bovis was compared with PPD's of M. bovis and M. avium for detecting antibodies in the sera of tuberculous swine. Greater ELISA reactions were detected in the sera of swine (originating from a herd in which M. avium serotype 1 was isolated) when M. avium PPD was used as compared to the KCl extract of M. bovis.

INTRODUCTION

Recent outbreaks of Mycobacterium bovis infection in swine in Hawaii and M. tuberculosis infection in swine in Washington has stimulated an interest in developing a rapid, reliable serologic test useful in detecting tuberculous swine. Delayed-type hypersensitivity tests currently used in the diagnosis of tuberculosis in swine requires that the intradermal test site be observed 48 hours following the injection of a purified protein derivative (PPD) or old tuberculin (OT); this necessitates the handling of animals two times. The need for a simple in vitro test has been further emphasized by reports which reveal that tuberculous lesions in swine can not be consistently differentiated on gross or microscopic examination.

The purpose of this investigation was to 1) evaluate a modified enzyme-linked immuno sorbent assay (ELISA) for detecting mycobacterial antibodies in sera of swine experimentally exposed to M. bovis, or to M. avium serotype 8. 2) compare ELISA reactions obtained using a potassium chloride extract of M. bovis strain 19210 and PPD's of M. bovis and M. avium and 3) to obtain information on ELISA reactions obtained in sera of swine originating from a herd in which M. avium serotype 1 infection was previously diagnosed on mycobacteriologic examination.

MATERIALS AND METHODS

Animals. Blood was collected from 8-week old swine before exposure to mycobacteria and at various intervals following exposure to M. bovis (0.01
DETECTION OF MYCOBACTERIAL ANTIBODIES IN SERA

mg intratrachially) or to *M. avium* serotype 8 (25 mg orally). The sera were stored at \(-20^\circ\)C. Sera were collected from swine naturally exposed to *M. avium* serotype 1 before injection of *M. avium* PPD. Sera from 10 representative animals were included in this investigation; seven were positive on tuberculin skin test.

**Preparation of inoculum.** Subcultures of *M. avium* serotype 8 were prepared on Middlebrooks' 7H10 medium for 3 weeks. The growth was washed from the surface, centrifuged and weighed. *M. bovis* was cultured on Stonebrinks' medium for 8 weeks and harvested as described above.

**Tuberculin skin tests.** Intradermal tuberculin tests were made on the dorsal surface of the ear in swine experimentally exposed to *M. bovis* or to *M. avium* serotype 8. *M. bovis* exposed pigs were tested at 5 weeks post-exposure and *M. avium* serotype 8 pigs were tested 6 weeks postexposure. Naturally exposed pigs received tuberculin-skin tests using *M. avium* PPD and *M. bovis* PPD immediately prior to slaughter.

**Mycobacteriologic examination.** Tissues collected at necropsy from swine experimentally exposed to *M. bovis* or to *M. avium* were processed using 2% NaOH as described previously. Inoculated slants were incubated at 37\(^\circ\)C for 8 weeks; isolates were identified by biochemical and/or seroagglutination tests.

**Mycobacterial Antigens for ELISA.** A potassium chloride extract of *M. bovis* strain 19210 was prepared as previously described by Hall and Thoen. The PPD's of *M. bovis* and *M. avium* used were prepared by ammonium sulfate precipitation of culture filtrate.

**Conjugate.** Affinity purified goat antiporcine IgG (H+L) (lot # CM11–1)\(^a\) labeled with horseradish peroxidase was obtained commercially. The conjugate was used at a dilution of 1:500 in 0.5 \(M\) NaCl containing 1% Tween 80 and 1% bovine serum albumin.

**Substrate.** A working solution of substrate was prepared using \(H_2O_2\) and 2–2' azinodi–(3 ethyl benthiozalin-sulfonate) in citric acid.

**ELISA Procedure.** The ELISA was conducted by modification of procedures described previously.\(^b\) First fifty ul of antigen diluted in 0.1 \(M\) \(Na_2CO_3\) and 50 ul of carbodiimide (Cyanamide)\(^b\) (1 mg/ml) diluted in 0.1 \(M\) \(Na_2CO_3\) was added to each well. The plates were placed in a plastic container and incubated at 4\(^\circ\)C for 16 hours. The cuvettes were washed three times with PBS. The 100 ul of 0.1 \(M\) \(NH_4Cl\) was added to each well and incubated at 22\(^\circ\)C for 30 minutes. The plates were washed 3 times with 0.5 \(M\) NaCl containing 0.5% Tween 80 adjusted to pH 7.5 with \(N\) \(NaOH\) (wash solution). Fifty ul of serum diluted 1:20 in 0.5 \(M\) NaCl containing 1% Tween 80 and 1% bovine serum albumin (diluent) was added to the first well and two fold dilutions of serum were made (1:40 to 1:320). The plates were incubated on a shaker at 22\(^\circ\)C for 15 minutes and then were washed 8 times with wash solution. Fifty ul of the conjugate diluted 1:500 in the

\(^a\) Kirkegaard and Perry Laboratories, Gaithersburg, Maryland 20760

\(^b\) Sigma Chemical Company, St. Louis, MO 63178
diluent was added to each well; the plates were incubated 15 minutes on the horizontal shaker and washed 8 times. The plates were inverted on a towel for one hour to dry. One hundred-fifty ul of substrate was added to each well and the plates were incubated for one hour. One hundred ul of distilled water was added to each well. The color intensity was measured using the Gilford PR-50 processor reader at 405 nm.

RESULTS

The results comparing ELISA reactions in sera of swine experimentally exposed to *M. bovis* are shown in Table 1. Serum collected from a representative animal (no. 93) before exposure and at 3 weeks following exposure to *M. bovis* revealed dramatic increases in ELISA reactions using *M. bovis* PPD or an antigen extracted from *M. bovis* using potassium chloride as compared to the reaction obtained using *M. avium* PPD. Greater ELISA reactions were detected in serum collected at 6 weeks postexposure; however, the difference in ELISA reactions for *M. bovis* and *M. avium* antigens was less than at 3 weeks postexposure. Important increases in ELISA reactions were detected at 5 weeks postexposure in sera of 3 of 4 other swine (nos. 15, 32 and 40A) using *M. bovis* PPD. However, positive ELISA reactions were detected in all 4 animals using the KCl extract of *M. bovis*. The ELISA reactions obtained using *M. avium* PPD at 5 and 10 weeks postexposure were less than reactions detected using *M. bovis* antigens.

A comparison of ELISA reactions in sera of swine exposed to *M. avium* complex serotype 8 are shown in Table 2. Elevated ELISA reactions were detected in sera of each of the 3 swine at 9 weeks postexposure as compared to values obtained on sera collected before exposure using each of the three mycobacterial antigens. Similar ELISA reactions were observed using *M. avium* PPD or *M. bovis* PPD or the KCl extract of *M. bovis*.

The results of ELISA reactions in sera of 10 swine originating from a herd in which *M. avium* complex serotype 1 was isolated are shown in Table 3. Positive tuberculin skin tests were observed using *M. avium* PPD in 7 of 7 swine. Two animals (nos. 9 and 27) had grossly visible lesions on slaughter. Three animals (nos. 1, 19 and 27) did not receive tuberculin skin tests. Similar ELISA reactions were obtained using *M. avium* PPD and *M. bovis* PPD. However, greater ELISA reactions were detected in each of the 10 sera using *M. avium* PPD as compared to reactions detected in sera using a KCl extract of *M. bovis*.

DISCUSSION

The failure to detect specific ELISA reactions in sera of swine experimentally exposed to *M. avium* complex serotype 8 may be in part attributed to the use of *M. avium* PPD prepared from serotype 1. Additional studies are needed to determine ELISA reactions in sera using PPD's prepared from various serotypes of *M. avium* complex. The specificity of ELISA reactions may be further increased by the use of certain extracts of *M. avium* prepared using KCl or Triton X–100.6

The results of enzyme immunoassay presented herein on sera of swine
DETECTION OF MYCOBACTERIAL ANTIBODIES IN SERA

experimentally exposed to *M. bovis* or naturally exposed to *M. avium* serotype 1 provide evidence that the ELISA test may be useful in screening swine sera for specific mycobacterial antibodies. However, further studies are necessary on swine naturally infected with *M. bovis* and infected with the different serotypes of *M. avium* complex.

Recent reports on isolation of mammalian tubercle bacilli from slaughter swine emphasizes the need to continually screen slaughter animals since these bacteria are of public health significance. Additional reports on the isolation of *M. avium* complex from humans could further emphasize the significance of developing rapid reliable tests for detecting tuberculous swine.

ACKNOWLEDGEMENTS

This work was supported in part by a special grant (No. 901–15–125) from Science and Education Administration, U.S. Department of Agriculture, Washington, D.C. The authors acknowledge the technical assistance of Judy A. Bruner and Wilma G. Eacret.

REFERENCES


Table 1. Comparison of ELISA reactions in sera of swine experimentally exposed to *Mycobacterium bovis*.

<table>
<thead>
<tr>
<th>Animal Number</th>
<th>M. bovis-PPD</th>
<th>M. avium-PPD</th>
<th>KCl-M. bovis</th>
</tr>
</thead>
<tbody>
<tr>
<td>93 Pre-exp.</td>
<td>0.11</td>
<td>0.16</td>
<td>0.14</td>
</tr>
<tr>
<td>3-weeks</td>
<td>1.01</td>
<td>0.41</td>
<td>1.28</td>
</tr>
<tr>
<td>6-weeks</td>
<td>1.65</td>
<td>1.18</td>
<td>1.52</td>
</tr>
<tr>
<td>15 Pre-exp.</td>
<td>0.05</td>
<td>0.06</td>
<td>0.10</td>
</tr>
<tr>
<td>5-weeks</td>
<td>0.22</td>
<td>0.12</td>
<td>0.22</td>
</tr>
<tr>
<td>10-weeks</td>
<td>0.57</td>
<td>0.26</td>
<td>NT</td>
</tr>
<tr>
<td>40 Pre-exp.</td>
<td>0.06</td>
<td>0.10</td>
<td>0.09</td>
</tr>
<tr>
<td>5-weeks</td>
<td>0.08</td>
<td>0.08</td>
<td>0.20</td>
</tr>
<tr>
<td>10-weeks</td>
<td>0.18</td>
<td>0.18</td>
<td>0.36</td>
</tr>
<tr>
<td>32 Pre-exp.</td>
<td>0.06</td>
<td>0.06</td>
<td>0.05</td>
</tr>
<tr>
<td>5-weeks</td>
<td>0.88</td>
<td>0.29</td>
<td>0.53</td>
</tr>
<tr>
<td>40A Pre-exp.</td>
<td>0.12</td>
<td>0.09</td>
<td>0.19</td>
</tr>
<tr>
<td>5-weeks</td>
<td>1.11</td>
<td>0.87</td>
<td>1.04</td>
</tr>
</tbody>
</table>

*absorbance at 405 nm; serum dilution 1:80
### Table 2. Comparison of ELISA reactions in sera of swine experimentally exposed to *Mycobacterium avium* serotype 8.

<table>
<thead>
<tr>
<th>Animal Number</th>
<th>ELISA Reactions*</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>M. bovis-PPD</td>
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<tr>
<td>96</td>
<td></td>
</tr>
<tr>
<td>pre-exp.</td>
<td>0.10</td>
</tr>
<tr>
<td>9-weeks</td>
<td>0.37</td>
</tr>
<tr>
<td>97</td>
<td>0.05</td>
</tr>
<tr>
<td>Pre-exp.</td>
<td>0.22</td>
</tr>
<tr>
<td>9-weeks</td>
<td>0.10</td>
</tr>
<tr>
<td>98</td>
<td>0.17</td>
</tr>
</tbody>
</table>

*absorbance at 405 nm, serum dilution 1:80
Table 3. Comparison of ELISA reactions in sera of swine naturally exposed to *Mycobacterium avium* serotype 1.

<table>
<thead>
<tr>
<th>Animal Number</th>
<th>M. bovis-PPD</th>
<th>M. avium-PPD</th>
<th>KCl-M. bovis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.68</td>
<td>0.65</td>
<td>0.59</td>
</tr>
<tr>
<td>9*(L)</td>
<td>1.51</td>
<td>1.35</td>
<td>0.69</td>
</tr>
<tr>
<td>13*</td>
<td>0.77</td>
<td>0.90</td>
<td>0.35</td>
</tr>
<tr>
<td>19</td>
<td>0.56</td>
<td>0.74</td>
<td>0.49</td>
</tr>
<tr>
<td>21*</td>
<td>1.28</td>
<td>1.07</td>
<td>0.39</td>
</tr>
<tr>
<td>23*</td>
<td>1.64</td>
<td>1.38</td>
<td>0.57</td>
</tr>
<tr>
<td>27 (L)</td>
<td>1.30</td>
<td>0.98</td>
<td>0.38</td>
</tr>
<tr>
<td>35*</td>
<td>2.04</td>
<td>1.87</td>
<td>0.77</td>
</tr>
<tr>
<td>38*</td>
<td>2.16</td>
<td>1.49</td>
<td>0.85</td>
</tr>
<tr>
<td>39*</td>
<td>1.36</td>
<td>0.98</td>
<td>0.32</td>
</tr>
<tr>
<td>mean</td>
<td>1.33</td>
<td>1.14</td>
<td>0.54</td>
</tr>
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</table>

\( ^a \) absorbance value at 405 mm, serum dilution 1:80.

* positive on tuberculin skin test

L=lesions observed at slaughter.
FOLLOW-UP SURVEY OF FERAL SWINE FOR MYCOBACTERIUM BOVIS INFECTION ON THE HAWAIIAN ISLAND OF MOLOKAI

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D. E. Stallknecht, Research Coordinator, Southeastern Cooperative Wildlife Disease Study, Department of Parasitology, College of Veterinary Medicine, University of Georgia, Athens, Georgia

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This study was supported in part by the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Veterinary Services (VS) through Cooperative Agreement Number 12-16-5-2230 with the Southeastern Cooperative Wildlife Disease Study (SCWDS), Department of Parasitology, College of Veterinary Medicine, University of Georgia, Athens, Georgia.

Concern of wildlife involvement in the epidemiology of bovine tuberculosis on Molokai followed the discovery, in October 1978, of a large infected herd on a 7,000 acre ranch located on the East end of the island. Mycobacterium bovis had been isolated from wild axis deer (Axis axis) on Molokai on four occasions between 1962 and 1972 (Sawa 1974). All cases were found on the East side of the island. A survey of axis deer and feral swine (Sus scrofa) was conducted during the summer of 1980 by the Southeastern Cooperative Wildlife Disease Study (SCWDS). This survey disclosed a 20% prevalence of M. bovis infection in feral swine on the affected ranch and adjoining State forest. Nine culture positive, and three histopathologic positive, culture negative swine were detected in 61 animals sampled. No evidence of infection was detected in 100 axis deer collected, but M. bovis was isolated from an axis deer killed by a hunter in February 1981. (Essey, et al 1981).

The infected cattle herd was depopulated in the fall of 1981. On May 20, 1981, the ranch and adjoining State forest was declared “open” for controlled public hunting of wild swine (Landgraf, 1981). The objective was to eliminate as nearly as possible the infected feral swine “family” with the hope that the focus of infection would prove highly limited in scope. This procedure was based on the finding by Griffin (1972) that, given an adequate food supply, island swine movements are not extensive. If successful, this procedure could then be employed on other foci of infection that may be subsequently disclosed.

* Dr. Frank A. Hayes, Director, SCWDS, University of Georgia, Athens, Georgia, 589
The area was avidly hunted for about a year. Restocking of the ranch with cattle occurred in 1982. A second wildlife disease survey was deemed necessary to determine (1) whether tuberculosis had been eliminated from the known affected swine family; if not, at what prevalence did it persist, and (2) whether infected wild swine populations existed in other parts of the island, especially on premises known to have been occupied by *M. bouis* infected herds. That had been depopulated. The services of the SCWDS were again used, whose findings are the subject of this report.

**METHOD**

A sample size of sixty (60) swine was selected to detect, at the 95% confidence level, one or more tuberculosis positive cases if infection existed at the 5% level or higher.

Subjects were given a post-mortem examination specifically designed for the detection of tuberculosis. Specimens for histopathology and culture were selected from all animals collected. Lymph glands showing no gross pathology were pooled and were preserved in 10% formalin and in saturated solution of sodium borate. Lymph gland pools consisted of parotid, mandibular, suprathyroidal, bronchial, mediastinal, and portal lymph glands. Where suspicious lesions were detected, that tissue was identified and preserved separately in formalin and in sodium borate. Tissues were forwarded to the National Veterinary Services Laboratory (NVSL), Ames, Iowa, for appropriate histopathology and culture. Histological evaluations were of H & E stained sections, and by Auramine O stained sections for acid-fast bacilli. Mycobacteriologic examinations were by the previously described method used at the NVSL (1974). Subjects were aged and sex, condition, and location of kill were recorded. Blood samples were collected for ELISA testing for tuberculosis and for the serologic detection of other diseases.

**RESULTS**

Sixty-eight (68) swine were collected. Eighteen (18) were reported with gross lesions indicative of tuberculosis. All were “negative for mycobacteriosis” on histopathologic examination. *M. bouis* was isolated from one case. This was an 18 month old female with calcified granuloma detected in the parotid, mandibular, suprathyroidal, mediastinal, bronchial, and portal lymph glands. Histopathologic classification of the case was “granuloma, unknown etiology.” The other 17 “lesioned” cases, as well as all other subjects of the study, were culture negative for *M. bouis* (table 1).

In eight cases, microscopic lesions (not mycobacteriosis) were seen in normal-appearing lymph glands. Microgranulomas seen in lymph nodes from some swine emphasize the necessity to collect nodes for laboratory examination from sites most likely to be infected with mycobacteria. Small lesions resembling parasite infections were seen in lymph nodes of some swine by microscopic examination that were not recognized on gross
examinations. Migrating parasite larvae can cause microgranulomas in lymph nodes as was believed to have happened among these specimens. One intact *Stephanurus* sp. larva was identified in a lung from one swine.\(^b\)

Most cases (33) were negative on gross examination and microscopically. No histopathology was conducted in nine cases, all grossly normal, because the decision to microscopically examine normal tissue was made after the project had started.

Thirty-one (31) swine were collected from the affected area surveyed in 1980; eleven (11) from the ranch, and 20 from the adjacent State forest. The single culture positive subject was among the 20, having been collected just within the State forest boundary. The balance of 37 swine were collected from other areas of Molokai inhabited by feral swine, and included premises known to have been occupied by *M. bovis* infected bovine. Eight (8) swine were collected on three ranch properties, and 29 from the State forest adjacent to several ranches. (Figure I)

The age class breakdowns for wild swine are shown on table 2. The swine collected on the affected ranch in 1983 were predominantly young animals (74% were less than 24 months of age). This is substantially different from the age class breakdown recorded in swine from the rest of Molokai during 1983, and from results observed on the affected ranch on the initial survey conducted in 1980 in which cases only about 31% of swine were under 24 months of age. This predominantly young age class structure is characteristic of heavily harvested populations and indicates that a good portion of the population had been removed since 1980.

**DISCUSSION**

The results of statistical analysis performed on the data for 1980 and 1983 are shown in Table 3. The prevalence of *M. bovis* in swine on the affected ranch, estimated at 19.67% in 1980, was reduced to 3.22% in 1983. At the 95% confidence limit the estimated prevalence for 1980 ranged from 11% to 35%, and for 1983 from >0 to 17%. It was concluded that a drop had occurred in the incidence of bovine tuberculosis in wild swine on the affected ranch between 1980 and 1983. This drop is statistically significant at the 5% level test. It can be concluded, with 95% confidence, that the present prevalence of *M. bovis* infection in wild swine is from just greater than zero to 17% on the affected ranch and from just greater than zero to 7% on the island.\(^c\)

---

\(^b\)Dr. John Greve, College of Veterinary Medicine, Iowa State University, personal communication.

\(^c\)Dr. Kenneth Pollock, Technical Director, Southeastern Fish and Game Statistics Projects, North Carolina State University, Raleigh, N.C.
The significant drop in prevalence can be attributed to two causes. First, the removal of the infected cattle herd had resulted in a reduction of exposure potential. The greatest reduction, however, was probably due to the reduction in swine numbers that resulted from the 1980 survey collection and the intensive public hunt that followed. Also, it is known that substantial “poaching” occurred after termination of the controlled hunting period.

The problem appears to be very localized. All positive cases (1980 and 1983) were collected within a few square mile area of a single ranch and adjoining State forest. This indicates that *M. bovis* did not spread from this locality either before or after the cattle herd depopulation. Localization of the problem also indicates that *M. bovis* infection did not spread from infected domestic herds to wild swine on any other premises known to have been occupied by infected cattle. Or, if it had spread to swine, the disease had disappeared spontaneously from the swine population following the depopulation of the affected cattle herds. In the opinion of the authors, the latter possibility is remote.

That *M. bovis* spreads within the swine population was conclusively shown in the case of the single culture positive case detected. The age of this subject was 18 months, which means that the animal was born after the herd depopulation. That *M. bovis* may spread efficiently through feral swine is indicated by the 1980 prevalence of 20% shown in wild swine compared to approximately 7% of lesioned cases found in the depopulated cattle herd.

Professional trapping and hunting over a long period was used in the successful elimination of *M. bovis* infection from feral swine on a large cattle ranch in California (Smith, 1968). It would appear that the best possible course of action on Molokai would be the employment of this same tactic.

**SUMMARY**

A statistically significant reduction in prevalence of *M. bovis* infection detected in feral swine on Molokai was seen between an initial survey conducted in 1980 and a survey completed in 1983. The prevalence was shown as 20% on an affected ranch in 1980, and 3.2% in 1983. This reduction is attributed to the depopulation of an *M. bovis* infected cattle herd, and to intense hunting pressures that followed the declaration of a special, monitored, public hunting program. The affected area appears to be highly localized. No evidence was shown of transmission from cattle to wild swine on other premises known to have been occupied by *M. bovis* affected cattle herds. An appropriate follow-up would seem to be the use of professional hunters to achieve total elimination of affected and exposed swine from known foci of infection.

**REFERENCES**

HAWAIIAN ISLAND OF MOLOKAI


<table>
<thead>
<tr>
<th>TABLE I</th>
</tr>
</thead>
</table>

**MOLOKAI WILDLIFE SURVEY**

1983

<table>
<thead>
<tr>
<th>FERAL SWINE</th>
<th>HISTO (MYOC\text{\textregistered}\text{\textregistered}ACTERIOSIS)</th>
<th>CULTURE (M. BOVIS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NEG</td>
<td>POS</td>
</tr>
<tr>
<td>68 COLLECTED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUSPICIOUS LESIONS</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>PARASITIC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>GUE*</td>
<td>7</td>
<td>7</td>
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<tr>
<td>OTHER</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>N.S.P.*</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>***NGL WITH MICRO LESIONS 8</td>
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</tr>
<tr>
<td>GUE</td>
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<td>5</td>
</tr>
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<td>3</td>
</tr>
<tr>
<td>NGL &amp; HISTO NEG</td>
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<td>33</td>
</tr>
<tr>
<td>NGL &amp; NO HISTO.</td>
<td>9</td>
<td></td>
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<tr>
<td>TOTALS</td>
<td>68</td>
<td>59</td>
</tr>
</tbody>
</table>

* GUE - Granuloma, Unknown Etiology
** NSF - No significant Findings
*** NGL - No Gross Lesions Detected
FIGURE 1

DISTRIBUTION OF FERAL SWINE COLLECTED
1983 SURVEY

○ GROSS LESIONS REPORTED (NEG HISTO)
☒ CULTURE POSITIVE (NEG HISTO)

........STATE FOREST BOUNDARY LINE
ENCIRCLED IS AREA OF 1980 SURVEY
TABLE 2

Age Class Breakdown for Wild Swine

<table>
<thead>
<tr>
<th>Age in Months</th>
<th>Number 1983</th>
<th>% 1983</th>
<th>Number 1980</th>
<th>% 1980</th>
<th>Number 1983</th>
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<tr>
<td>&gt;8</td>
<td>5</td>
<td>16</td>
<td>1</td>
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<td>0</td>
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<td>8-14</td>
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<td>8</td>
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<td>14-24</td>
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<td>55</td>
<td>11</td>
<td>18</td>
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<tr>
<td>24+</td>
<td>8</td>
<td>26</td>
<td>42</td>
<td>69</td>
<td>25</td>
<td>68</td>
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<tr>
<td>Total</td>
<td>31</td>
<td>100</td>
<td>61</td>
<td>100</td>
<td>37</td>
<td>100</td>
</tr>
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</table>

TABLE 3

Prevalence of *M. bovis* in Feral Swine on Molokai

<table>
<thead>
<tr>
<th>Histo or Culture pos.</th>
<th>Point Estimate</th>
<th>Prevalence</th>
<th>95% Confidence Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980 12/61</td>
<td>19.67%</td>
<td>11%&lt;p&lt;35%</td>
<td>Affected Ranch</td>
</tr>
<tr>
<td>1983 1/31</td>
<td>3.22%</td>
<td>0%&lt;p&lt;17%</td>
<td>Affected Ranch</td>
</tr>
<tr>
<td>1983 1/68</td>
<td>1.47%</td>
<td>0%&lt;p&lt;7%</td>
<td>Entire Island</td>
</tr>
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</table>
RETROSPECTIVE STUDY OF BOVINE TUBERCULOSIS CASES FOUND ON SLAUGHTER SURVEILLANCE IN THE UNITED STATES WITH PARTICULAR REFERENCE TO FEEDLOT CATTLE OF MEXICAN ORIGIN

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The problem of bovine tuberculosis in feedlot animals has been previously reported. (Essey, et. al. 1982) In 1979, for the first time, the percentage of tuberculosis positive cases found in feedlot cattle on slaughter surveillance exceeded that found in adult cattle of farm or ranch origin (Figure 1). In 1982, feedlot cases accounted for 41 (93%) of the 44 cases investigated. This trend continued in 1983 with 17 (63%) feedlot cases of 27 cases investigated. (Hosker, 1983)

The emergence of feedlots as the major source of tuberculosis cases parallels an increasing incidence of cases traced directly to Mexico, or that are associated with cattle of Mexican origin. The purpose of this current study was to verify the extent of infection traceable to imported cattle so that the exposure potential of domestic cattle to tuberculosis from this source can be better assessed.

Method: All slaughter surveillance cases investigated in the U.S. from 1978 through 1983 were reviewed. Cases that were not sufficiently investigated (for reasonable assurance of origin), or where Mycobacterium avium was isolated, were not included in the tabulations.

Results: Figure 2 compares tuberculous feedlot cases according to source; Mexico vs. domestic. Also shown in Table II are the numbers of cattle imported from Mexico by fiscal year. While Mexican cases accounted for 3 (16%) of 19 feedlot cases in 1978, 22 (71%) of 31 feedlot cases were attributed to Mexico in 1979, and 29 (81%) of 36 cases in 1980. In 1981, cases from Mexico accounted for slightly less than half, 16 vs. 17. In 1982, the percentage of cases attributed to Mexico again rose to 81% (26 of 32 feedlot cases investigated). When based on affected carcasses found, the 1982 figure soars to 92% (68 of 74 total cases, resulting from multiple carcasses condemned in some slaughter lots). Again in 1983, Mexican origin cases predominated with 13 (76%) of 17 feedlot cases investigated.

Table 1 presents this same information in more detail. Over a five year
span a total of 149 feedlot cases were considered, of which 106 (71%) were credited to Mexico, and 43 (29%) to domestic sources. It should be noted that in most cases the Mexican origin was known (91) vs. 15 cases where the conclusions were based on reasonable assumption. In about the same proportion of cases, the "domestic" origin was also based on reasonable assumption.

The distribution of the 106 Mexican origin cases is shown in Table 2. The majority of cases, 61 (58%), were slaughtered in California. Ninety-three percent of all cases were slaughtered in the states of California, Texas, and Arizona. The balance of 7 cases were slaughtered in four additional states; two each in New Mexico, Kansas and Nebraska, and one in Florida. The slaughtering state, in most cases, was the final feedlot state.

Two or more states were involved in the investigation of most cases. Texas (42 investigations) and Arizona (26 investigations) were additionally involved in more cases than all other states combined (as the port of entry, pasture, or feedlot state). Nine additional states were involved in a total of 19 investigations. In most cases they were the pasturing state or the final feedlot state. Those were: Oklahoma 6, New Mexico 4, Colorado 2, Mississippi 2, and one case each in Louisiana, Idaho, Nevada, Wyoming, and Kansas.

DISCUSSION

The problem appears to be regional — involving primarily California, Texas, and Arizona. Eleven other states were involved in only a small number of cases. Those states, however, contain substantial livestock populations. Although there has been no known instance where *M. bovis* infection had spread from this source to domestic herds, this potential should be recognized. Considering the insidious nature of bovine tuberculosis one can reasonably assume that, by the time the first case is discovered, widespread dissemination of the disease will have already occurred.

Case reviews indicate that the potentiality for domestic exposure is good. Several instances of known exposure were reported. In two cases "poor doers" were moved from feedlots into marketing channels and were later found to be extensively lesioned at slaughter. Other cases involved steers that were moved out for use as roping steers in rodeo circuits. Virtually never is an effort made to trace exposed animals from affected lots or pastures that may have left for reasons other than slaughter. In one instance where such tracing had been done, exposed animals were traced to a dairy herd; others were untraceable thru dealers. Movements of "poor doers" and exposed cattle from undetected but affected lots (pasture or feedlot) into marketing channels may present a more serious threat to the United States cattle industry than previously recognized.

Figure 2 shows that from 1978 through 1982 there had been a steady decline in the number of animals imported each year from Mexico — from 686,000 in 1978 to 320,000 in 1982. This same period was accompanied by a significant increase in tuberculous cases found in these cattle. This may
Indicate an increase in the prevalence of bovine tuberculosis in parts of Mexico. In 1983, for the first time in recent years, the number of imported cattle increased significantly (496,000 head). Considering a time lapse from entry to slaughter of 18 to 24 months, one can project for the years 1985 and 1986 a significant increase in the number of tuberculosis positive cases found on slaughter. This will be, in part, a direct reflection of the increased risk of domestic cattle exposure to tuberculous cattle of Mexican origin.

There appears to be the need for a comprehensive review of United States import requirements directed towards the adoption of procedures acceptable to both countries that would minimize potential spread of tuberculosis to domestic cattle. As an example, a post-entry tuberculin test should effectively detect tuberculous lots. Where tuberculosis is confirmed as the result of such test, all further movements of such known exposed animals would be under the same restrictions that are imposed on known exposed domestic cattle.

In the opinion of the authors, the true solution to the problem lies in the eradication of bovine tuberculosis from the country of Mexico. This concept far surpasses the need for the protection of gains made by the United States in its bovine tuberculosis eradication efforts. Its benefits would include not only the alleviation of human and animal suffering, but also the recovery of the Mexican livestock industry from a disease that promises only continuing economic erosion. This may be the appropriate time for the governments of the United States and Mexico to enter into a joint effort that would lead eventually to the eradication of bovine tuberculosis for the lasting benefit of both countries.

**SUMMARY**

A five-year trend continues that shows feedlots as the predominant source of tuberculosis found on slaughter surveillance in the United States. A correlation is shown of an increase in the percentage of tuberculous cases traced to Mexico; 106 (71%) of 149 total feedlot cases studied. Case reviews indicate that the greatest potential for spread of tuberculosis from this source may be the movement of tuberculous "poor doers" and exposed animals from pastures and feedlots into marketing channels. Recommendations offered are (1) the strengthening of the United States import requirements and (2) the embarkation of the United States and Mexico in a joint effort that would lead to the eventual eradication of bovine tuberculosis from Mexico.

**REFERENCES**

FIGURE 1

VS FORM 6-35 POSITIVE TB CASES
(REGULAR KILL) FEEDLOT

<table>
<thead>
<tr>
<th>FY</th>
<th>FEEDLOT</th>
<th>ADULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>78</td>
<td>21</td>
<td>45</td>
</tr>
<tr>
<td>79</td>
<td>34</td>
<td>28</td>
</tr>
<tr>
<td>80</td>
<td>38</td>
<td>14</td>
</tr>
<tr>
<td>81</td>
<td>39</td>
<td>14</td>
</tr>
<tr>
<td>82</td>
<td>41</td>
<td>3</td>
</tr>
<tr>
<td>83</td>
<td>17</td>
<td>10</td>
</tr>
</tbody>
</table>
FEEDLOT CASES TB POSITIVE & NUMBER OF CATTLE IMPORTED FROM MEXICO

MEXICO

VS.

DOMESTIC

NUMBER IMPORTED IN THOUSANDS

* Feedlot cases traced to Mexico presented as number of carcasses condemned.
### Table 1

**Origin of TB Positive Feedlot Cases vs 6-35 (Regular Kill)**

<table>
<thead>
<tr>
<th>FY</th>
<th>Feedlot Total</th>
<th>M. Bovis &amp; Full Inv.</th>
<th>Known</th>
<th>Assoc</th>
<th>Total</th>
<th>Mexico Origin</th>
<th>Domestic Origin</th>
<th>Cases Not Considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>83</td>
<td>18</td>
<td>17</td>
<td>12</td>
<td>1</td>
<td>13</td>
<td>76.5%</td>
<td>4</td>
<td>23.5%</td>
</tr>
<tr>
<td>82</td>
<td>40</td>
<td>32</td>
<td>23</td>
<td>3</td>
<td>26</td>
<td>78.8%</td>
<td>6</td>
<td>15.0%</td>
</tr>
<tr>
<td>81</td>
<td>41</td>
<td>33</td>
<td>12</td>
<td>4</td>
<td>16</td>
<td>48.5%</td>
<td>17</td>
<td>51.5%</td>
</tr>
<tr>
<td>80</td>
<td>39</td>
<td>36</td>
<td>25</td>
<td>4</td>
<td>29</td>
<td>80.5%</td>
<td>7</td>
<td>19.5%</td>
</tr>
<tr>
<td>79</td>
<td>37</td>
<td>31</td>
<td>19</td>
<td>3</td>
<td>22</td>
<td>71%</td>
<td>9</td>
<td>29%</td>
</tr>
</tbody>
</table>

* Reasonably assumed to be of Mexican origin

** Not sufficiently investigated
### TABLE 2

**VS 6-35 POS. TB CASES - FEEDLOT**  
**MEXICO ORIGIN ONLY**  
**DISTRIBUTION OF CASES**

<table>
<thead>
<tr>
<th>FY</th>
<th>SLAUGHTER STATE (USUALLY FINAL FEEDLOT)</th>
<th>ALL OTHER</th>
<th>OTHER STATES INVOLVED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CA</td>
<td>AZ</td>
<td>TX</td>
</tr>
<tr>
<td>83</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>82</td>
<td>14</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>81</td>
<td>8</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>80</td>
<td>13</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>79</td>
<td>16</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>61</td>
<td>14</td>
<td>24</td>
</tr>
</tbody>
</table>

**TOTAL 106**  
58% CA  
13% AZ  
23% TX  
7% NB

TOTAL 87

States involved:
- OK: 6
- NM: 4
- CO: 2
- MS: 2
- LA: 1
- ID: 1
- NV: 1
- WY: 1
- KS: 1

78%  
93%  
7%
APPLICATION OF A MODIFIED ENZYME-LINKED IMMUNOSORBENT ASSAY FOR DETECTING MYCOBACTERIAL ANTIBODIES IN THE SERA OF CATTLE FROM A HERD IN WHICH MYCOBACTERIUM BOVIS INFECTION WAS DIAGNOSED.

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Supported by Cooperative Agreement No. 12–16–5–2206 from Veterinary Services, APHIS, U.S. Department of Agriculture, Hyattsville, MD.

SUMMARY

A routine enzyme-linked immunosorbent assay (ELISA) and a modified ELISA were used for detecting mycobacterial antibodies in the sera of cattle in a herd in which Mycobacterium bovis infection was diagnosed previously. Affinity purified goat-antibovine IgG (H+L) labeled with horseradish peroxidase was used as the conjugate and M. bovis purified protein derivative (PPD) tuberculin was used as the antigen. Improved results were obtained in detecting mycobacterial antibodies in the sera of tuberculous cattle when a modified ELISA with carbodiimide and NH₄Cl was used. Reactions on modified ELISA were detected in sera of 77 of 80 adult cows responding on tuberculin skin tests conducted in the vulva and/or caudal fold and on comparative cervical tuberculin skin tests; 43 cattle had gross lesions at slaughter. Moreover, ELISA reactions were detected in sera of 44 of 46 cattle responding on tuberculin skin tests conducted in the vulva and/or caudal fold and negative on comparative cervical tuberculin skin tests; 20 cattle had gross lesions. ELISA reactions were also detected in sera of 24 of 196 cattle negative on tuberculin skin tests conducted on the vulva and/or caudal fold and not receiving comparative cervical tuberculin tests.

INTRODUCTION

Serologic tests including complement fixation, bentonite flocculation, passive hemagglutination, indirect immunofluorescent antibody and precipitation in gel have been previously described for use in identifying tuberculous cattle.¹⁻⁶ These procedures have not come into widespread use because nonspecific reactions have been reported to occur in some cattle.⁷ Moreover, it has been reported that animals receiving repeated tuberculin skin tests may develop serologic reactions which interfere with interpretation of test results.¹²³
Enzyme-linked immunosorbent assays (ELISA) have been developed for detecting tuberculous swine, nonhuman primates, man and certain exotic hoofed animals. Recently, we have reported on the use of a modified ELISA for identifying mycobacterial antibodies in the sera of cattle experimentally exposed to or naturally infected with Mycobacterium paratuberculosis.

The purpose of this study was to evaluate a routine ELISA and a modified ELISA for detecting the presence of mycobacterial antibodies in the sera of cattle in a herd in which bovine tuberculosis was diagnosed and to compare ELISA reactions and tuberculin skin responses.

MATERIALS AND METHODS

Animal Sera. Blood was collected from each of 322 cattle in a herd in which M. bovis infection had been diagnosed. Of the 322 cattle tested 126 had responses on tuberculin skin tests conducted in the vulva and in caudal fold (V/CF); 80 of the 126 cattle were subsequently found to have positive reactions on comparative cervical (C-C) tuberculin skin tests. The remaining 46 animals responding in V/CF tests were negative on C-C tuberculin tests. One hundred ninety-six cattle failed to respond to tuberculin skin tests conducted in the vulva and caudal fold.

Mycobacteriologic Examinations. Tissues were collected from some cattle with grossly visible lesions at slaughter for culture; these tissues were processed with 2% NaOH as described previously.

ELISA Antigen. The antigen used in the ELISA was purified protein derivative prepared by (NH₄)₂SO₄ precipitation of the culture filtrate of M. bovis strain AN-5 (USDA No. 31901). The PPD tuberculin (1 mg/ml) was diluted 1:100 in phosphate buffered saline pH 7.2 (PBS) or in 0.1 M Na₂CO₃ (pH 9.6) for the modified ELISA.

Conjugate. Affinity purified goat-antibovine IgG (H + L chain) labeled with horseradish peroxidase (Lot CM10-1) was obtained commercially. Optimal ELISA reactions were obtained using a 1:500 dilution of the conjugate prepared in 0.5 M NaCl containing 1% Tween 80 and 1% bovine albumin (pH 7.5).

Substrate. A working solution of substrate was prepared using hydrogen peroxide and 2-2' azinodi-(3 ethyl benthiazoline-6-sulfonate; ABTS) in citric acid.

ELISA Procedure. A routine ELISA was conducted by modification of procedures described previously. Fifty µl of M. bovis PPD (1mg/ml) diluted 1:100 in PBS was added to separate wells of Gilford cuvettes and allowed to dry at 37°C for 16 hours. The cuvettes were washed 3 times. Fifty µl of serum diluted 1:40 in 0.5 M NaCl containing 1% Tween 80 and 1% bovine serum albumin (BSA) was added to the first well; 2-fold dilutions of serum were added to separate wells (1:80 to 1:640). After

* Kirkegaard–Perry Inc., Gaithersburg, MD.
incubation for 30 minutes on a horizontal shaker at 22°C the cuvettes were washed 8 times with 0.5 M NaCl containing 0.5% Tween 80 adjusted to pH 7.5 with 1 M NaOH. Fifty μl of the conjugate diluted to 1:500 using 0.5 M NaCl containing 1% Tween 80 and 1% BSA was added to each well and incubated for 30 minutes on the shaker. The plates were washed 8 times with wash solution and 150 μl of substrate solution was added to each well. The plates were incubated at 22°C and 100 μl of distilled water was added to each well. The color intensity of the reactions was determined at 1 hour using a Gilford PR-50 Processor Reader at a wavelength of 405 nm.

The modified ELISA was conducted similarly except 50 μl of carbodiimide\(^b\) (1 mg/ml) diluted in 0.1 M Na\(_2\)CO\(_3\) was added to each well at the time that antigen diluted in Na\(_2\)CO\(_3\) was added. The plates were incubated at 4°C for 16 hours and washed 3 times with PBS.\(^{16}\) Then 100 μl of 0.1 M NH\(_4\)Cl was added to each well on the plate. After incubation at 22°C for 30 minutes the plates were washed 3 times with wash solution.

RESULTS

A comparison of the reactions obtained using a routine and a modified ELISA on sera of 80 cattle responding on tuberculin skin tests conducted in the vulva and caudal fold and positive on comparative cervical tuberculin tests and on sera of 40 cattle negative on tuberculin skin tests are shown in Table 1. Consistently greater ELISA reactions (mean values) were detected in the sera (dilutions 1:80 to 1:640) of cattle responding on tuberculin skin test using a modified ELISA as compared to a routine ELISA (P < .01). No significant difference was observed in ELISA reactions (mean value) on sera of tuberculin test negative cattle using a modified or a routine ELISA (P > .05).\(^{16}\)

A comparison of ELISA results on sera of 80 cattle responding on tuberculin skin tests conducted in the vulva/caudal fold and cervical region are shown in Table 2. On routine ELISA 64 cattle were classified as positive, 4 were suspect and 12 were classified as negative. On the modified ELISA 70 cattle were classified as positive, 7 as suspect and 3 as negative; no grossly visible lesions were observed in 5 of the 7 suspects.

A comparison of the results of ELISA on sera of cattle (responding on tuberculin tests on vulva and caudal fold) positive on comparative cervical and cattle negative on comparative cervical tuberculin test are shown in Table 3. Seventy-seven of 80 cattle positive on comparative cervical tuberculin test had reactions on ELISA; 43 had grossly visible lesions on slaughter. \(M.\) bovis was isolated from 18 of 19 tissues submitted for culture. One of 3 cattle positive on comparative cervical tuberculin test and negative on ELISA had lesions in a prescapular lymph node. Gross lesions were observed in the cervical lymph nodes of 1 of 2 animals negative on comparative cervical tuberculin test and ELISA.

Comparisons of routine and modified ELISA results on sera of 196 cattle negative on tuberculin skin tests are shown in Table 4. ELISA reactions

\(^{b}\) Sigma Chemical Co., St. Louis, MO.
were detected in sera of 26 or 196 cattle negative on tuberculin tests using the routine test; sera from 14 cattle had positive reactions and 12 had suspicious reactions. Reactions on modified ELISA were detected in 24 of 196 cattle; 17 had positive reactions. Lesions were observed in 12 cattle on slaughter; \textit{M. bouis} was isolated from tissues of 10 of the 12 cattle. ELISA reactions were detected in sera of 3 of the 12 cattle with lesions.

**DISCUSSION**

Although several serologic tests have been described for identifying mycobacterial antibodies in the sera of cattle experimentally exposed to \textit{M. bouis}, these tests have not been widely used as diagnostic procedures for detecting antibodies in the sera of naturally exposed cattle.\textsuperscript{1,7} False-positive reactions are reported to occur in nontuberculous cattle, thereby limiting the practical value of these tests for screening slaughter cows.\textsuperscript{7} The modified ELISA described herein, successfully detected 77 of 80 cattle reported to have positive tuberculin skin test responses and/or tuberculous lesions. No grossly visible lesions were detected on necropsy in 2 of the 3 cows found negative; \textit{M. bouis} or other mycobacteria were not isolated from tissues. Since the sera examined were from cattle in a herd where bovine tuberculosis had been diagnosed previously, some possible explanations may be that these animals were recently exposed to \textit{M. bouis} or that defense mechanisms of the host had successfully limited the disease process. In either instance, mycobacterial antigens may not have been released in sufficient quantity to stimulate the production of antibody levels detectable on ELISA. Further studies using more refined antigens with increased sensitivity and specificity may improve the efficacy of ELISA in detecting cows recently exposed to \textit{M. bouis} and animals with minimal disease.\textsuperscript{17,22} In this study the only conjugate used was antibovine IgG (H+L). Additional investigations should include an evaluation of subclass specific antispecies conjugates for detecting the relative amounts of IgG\textsubscript{1} and of IgG\textsubscript{2}.\textsuperscript{18}

Bovine tuberculosis has been reduced to a low level in the United States.\textsuperscript{19} Therefore the importance of ELISA reactions in sera of 24 cows negative on tuberculin skin test is currently under evaluation. One may suspect that the 24 cows with ELISA reactions were recently infected with \textit{M. bouis} or exposed to other mycobacteria in the environment which share antigenic determinants with \textit{M. bouis}.\textsuperscript{20,21}

**ACKNOWLEDGEMENTS**

The authors wish to thank Dr. Ralph Hosker, Chief Staff Veterinarian, Cattle Diseases Staff, Veterinary Services, U.S. Department of Agriculture, Hyattsville, MD for coordinating this investigation.

We also appreciate the assistance of Dr. Elmer M. Himes, National Veterinary Services Laboratories, Veterinary Services, U.S. Department of Agriculture, Ames, IA, Dr. William Searles, Veterinary Services, U.S. Department of Agriculture, Austin, TX, and Dr. Howard N. Sturkie, Food Safety and Quality Service, U.S. Department of Agriculture, Palastine,
TX in collection of serum and tissue specimens.

The authors acknowledge the participation of Dr. C. Markham in conducting tuberculin tests and the cooperation of Dr. W. G. Smith, for providing information on the history of the herd.

The technical assistance of Wilma G. Eacret in conducting mycobacteriologic examinations is greatly appreciated.

REFERENCES


TABLE 1. RESULTS OF ENZYME-LINKED IMMUNOSORBENT ASSAYS CONDUCTED ON SERA OF 80 CATTLE RESPONDING ON TUBERCULIN SKIN TESTS IN VULVA, CAUDAL FOLD AND CERVICAL REGION AND 40 CATTLE NEGATIVE ON TUBERCULIN TEST.*

<table>
<thead>
<tr>
<th>Serum dilution</th>
<th>1:80</th>
<th>1:160</th>
<th>1:320</th>
<th>1:640</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Routine ELISA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>0.78&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.61</td>
<td>0.46</td>
<td>0.31</td>
</tr>
<tr>
<td>Negative</td>
<td>0.14</td>
<td>0.1</td>
<td>0.07</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Modified ELISA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>1.28</td>
<td>0.97</td>
<td>0.74</td>
<td>0.47</td>
</tr>
<tr>
<td>Negative</td>
<td>0.14</td>
<td>0.09</td>
<td>0.07</td>
<td>0.04</td>
</tr>
</tbody>
</table>

<sup>a</sup> Antigen - M. bovis PPD.
Conjugate - Goat-Antibovine IgG (H+L) labeled with HRPO.
<sup>a</sup> = absorbance at 405 nm (mean value).

TABLE 2. COMPARISON OF RESULTS OF A ROUTINE AND OF A MODIFIED ENZYME-LINKED IMMUNOSORBENT ASSAY ON SERA OF 80 CATTLE RESPONDING ON TUBERCULIN SKIN TESTS IN VULVA, CAUDAL FOLD AND CERVICAL REGION.

<table>
<thead>
<tr>
<th>ELISA</th>
<th>Positive&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Suspect</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routine</td>
<td>64</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Modified</td>
<td>70</td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>

<sup>a</sup> Positive = 2x ELISA mean value on sera of negatives.
TABLE 3. COMPARISON OF RESULTS OF A MODIFIED ELISA AND COMPARATIVE CERVICAL TUBERCULIN SKIN TESTS ON SERA OF 126 CATTLE RESPONDING ON TUBERCULIN SKIN TESTS CONDUCTED IN VULVA AND CAUDAL FOLD.

<table>
<thead>
<tr>
<th>ELISA</th>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>70\textsuperscript{a}</td>
<td>33</td>
</tr>
<tr>
<td>Suspect</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Negative</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

\textsuperscript{a} - number of sera

TABLE 4. COMPARISON OF RESULTS OF A ROUTINE AND OF A MODIFIED ENZYME-LINKED IMMUNOSORBENT ASSAY CONDUCTED ON SERA OF 196 CATTLE NEGATIVE ON TUBERCULIN SKIN TESTS*

<table>
<thead>
<tr>
<th>ELISA</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
</tr>
<tr>
<td>Routine</td>
<td>14</td>
</tr>
<tr>
<td>Modified</td>
<td>17</td>
</tr>
</tbody>
</table>

* Serum dilution of 1:160
Report on the International Colloquium on Research in Paratuberculosis

R.S. Merkal, PhD
From the National Animal Disease Center, Agricultural Research Service, US Department of Agriculture, PO Box 70, Ames, IA 50010.

The purpose of the International Colloquium on Research in Paratuberculosis, held at the National Animal Disease Center in Ames, Iowa, June 16-18, 1983, was to bring together paratuberculosis researchers from around the world, livestock producers, veterinary practitioners, and state and federal regulatory officials who are interested in the paratuberculosis problem.

This report is a general summary of the discussions at the Colloquium.

Incidence and distribution—One group of reports dealt with the incidence and distribution of paratuberculosis in the U.S. and in some of the other countries represented. Cultural surveys of cull cows at slaughter were reported from Wisconsin and Connecticut. In the Wisconsin survey, samples of ileo-cecal valves were taken from 1,000 randomly selected carcasses. The animals sampled were typical of those culled from Wisconsin beef and dairy herds. No attempt was made in the survey to distinguish between beef and dairy animals. An incidence of 10.8 percent was found in Wisconsin. In a smaller survey in Connecticut, in which mesenteric lymph nodes as well as the ileo-cecal valves and other tissues were cultured, 18 of 100 animals sampled yielded cultures of *M. paratuberculosis*.

In two separate herd surveys conducted by fecal culture in Illinois, 5 of 15 herds examined had one or more shedders, and in the second survey, 9 of 29 herds contained one or more shedders. This suggests that about 1/3 of the herds in Illinois were infected.

Costs of paratuberculosis—None of the countries represented at the Colloquium reported recent nationwide surveys of the incidence of paratuberculosis. The last national survey was in England several decades ago. It was considered the most economically important infectious disease in England at that time, and second only to mastitis and infertility as a reason to cull animals. However, the scientists from each of the countries perceived paratuberculosis to be a serious problem in their countries.

The estimated cost of the losses to Wisconsin dairy farmers based on that survey was $52,395,012 per year. This probably was a very conservative estimate because it was based on culturing only samples from the ileo-cecal valves, which are positive only about half as frequently as the ileo-cecal lymph nodes. Moreover, the losses due to increased mastitis and breeding problems in apparently infected paratuberculous cattle were not considered. However, if just that conservative estimate is divided by the number of dairy herds in the state, about 44,000, an average of $1,190 is being lost for every herd in the state. Using the Illinois estimate that one
out of every three herds is infected, then the average infected herd would be losing $3,570 per year. The average number of cows per herd in these states is between 40 and 60. Therefore, the cost to these livestock producers of owning a paratuberculosis infected herd is $60 to $80 per head, and well over $100 per head if the costs of paratuberculosis induced infertility and mastitis were added on.

However, its devastating effect can be even better recognized when it is understood that inapparently infected (subclinical) paratuberculous animals have 4 to 5 times higher incidence of mastitis and significantly more breeding problems than noninfected animals in the same herds, and an average 8 to 9% reduction in milk production, slower weight gains in growing animals, in addition to the losses due to clinical Johne's disease. The total losses were estimated to exceed $1.5 billion per year for the U.S. dairy industry.

Diagnostic tests are expected to perform many different functions. The producer with paratuberculosis in his herd needs a test that will tell him which animals are shedding the organisms, are dangerous to the remainder of his herd, and are most likely to develop the clinical syndrome. The buyer needs a test that will tell him which animals are infected, and he is not particularly interested in whether the individual animal eventually will become clinically ill or will recover. He just does not want to buy an infected animal that will introduce the disease into his herd. Importing countries are in the same position. They want to buy noninfected animals.

Diagnostic tests—Diagnostic tests that were evaluated for detection of paratuberculous animals included: enzyme-linked immunosorbent assay (ELISA), complement fixation (CF), agar gel immunodiffusion precipitin (AGID), crossed immunoelectrophoresis (CIE), immunoelectrophoretic blotting (IEB), radioimmunoassay (RIA), and immunoperoxidase (IIP) serologic tests; and lymphocyte transformation (LLT) and macrophage migration inhibition (MMI) cell mediated immune responses. Gas-liquid chromatography (GLC) and high performance liquid chromatography (HPLC) were evaluated, but so far only on cultured strains. These chemical methods have not yet been applied to fecal specimens. Direct microscopic examination of fecal and lymph node or rectal biopsy specimens and fecal culture were discussed.

a. Serologic tests:

Advances were reported in the purification and identification of the carbohydrate antigens responsible for complement fixation reactions. The evidence suggests that the CF active polysaccharide antigen is an aggregate, possibly lipid-dependent, expressing 2 antigenic determinants, one of which is aggregate dependent. The dissociated lipid-free form is non-complement fixing and is CF inhibitory for bovine serum.

The sensitivity of CF for use with sheep sera was increased by use of a fraction of unheated ovine serum which recognizes sheep immune complexes, thus allowing activation of guinea pig complement.
Up to 19 distinct *M. paratuberculosis* antigens were recognized by some animals in crossed immunoelectrophoresis, but only 2 were recognized by most of the infected animals relative to all strains of *M paratuberculosis*, and only one, designated antigen A, was uniformly recognized.

Numerous improvements in ELISA methods were reported. As in most of the serologic tests, more specific antigens had been prepared. A crude, soluble antigen preparation consisting of protoplasm from refrigerated French press ruptured *M paratuberculosis* was used by most investigators or served as the starting material for further fractionation. Most further fractionations started with the soluble protoplasm fraction obtained by centrifugation at 59,000 rcf. The greatest improvement in specificity was found by absorbing the test sera with a *Mycobacterium phlei* suspension. This procedure eliminated cross-reacting antibodies due to corynebacterial, nocardial, and most of the, *Mycobacterium bovis* and other nongroup III antigens. When sera of *M paratuberculosis* infected cattle were absorbed with *M phlei*, no reduction of ELISA index occurred, but when sera of tuberculous, corynebacterial infected, or CF positive but non-paratuberculous cattle were absorbed, the ratio of indices from non-absorbed, divided by the indices of the absorbed sera, always were greater than 2.

The specificity of AGID tests also was markedly improved by the above procedures; however, it is less sensitive than the ELISA. An overall evaluation of currently available serodiagnostic tests suggests that ELISA usually detects individual paratuberculous animals earlier than AGID or CF, the latter two usually not becoming positive until relatively high numbers of *M paratuberculosis* are being shed.

b. Culture tests:

Fecal culture was reported to be both 100% specific and nearly 100% sensitive on a herd basis. On an individual animal basis, it still is 100% specific, and the sensitivity has been increased by recent developments. It now can detect one organism or less per gram of feces, which means that in many cases a positive fecal culture can be obtained as early as when the most sensitive serologic test will be positive.

Several changes in cultural techniques have led to the improved diagnostic capability of fecal culture. The first was a switch from the use in the isolation medium of mycobactin P, made from *M phlei*, to the use of the homologous mycobactin J, produced by a laboratory adapted strain of *M paratuberculosis*. In most cases this reduced the incubation time required to visualize colonies by about 3 weeks. More importantly, the numbers of colonies on mycobactin J-containing medium usually was 10 to 50% higher, more infected animals were detected, and some strains were absolutely dependent on the presence of mycobactin J and would not grow on medium containing only mycobactin P.

The second change in technique that added to the diagnostic value of fecal culture was substitution of hexadecylpyridinium chloride (HPC) for the previously used benzalkonium chloride as a decontaminant. After
decontamination with HPC, the colony counts were higher and more animals were detected in the samples treated with HPC than in identical samples treated with benzalkonium chloride. Moreover, it is readily feasible to use a 10 to 20 fold larger fecal specimen with HPC than with benzalkonium chloride, thereby increasing the number of organisms detected by one log or more.

In the technique currently being used, the fecal specimen is shaken with 5 to 10 volumes of 0.75% HPC for 30 minutes, then the straw and heavy particles are allowed to settle for several minutes, and the supernatant suspension is transferred into another tube or taken up into a transfer pipette. After several hours or overnight, the sediment is inoculated onto egg-yolk medium containing mycobactin J.

Some strains of *M paratuberculosis* grow more rapidly on medium containing 0.4% sodium pyruvate, while a very small proportion of strains are inhibited by it. In addition, some rapidly growing contaminants also are stimulated by pyruvate. Therefore, each decontaminated specimen should be inoculated onto tubes of medium with and without pyruvate.

Cultural sensitivity of 100 organisms per gram was attained many years ago. Current techniques allow the detection of 1 organism or less per gram, and have reduced the time of primary identification from 12 or more weeks to 8 weeks or less, at which time 8 out of 9 animals that are shedding the organisms can be identified. About 10% of specimens require more than 8 weeks and about 1% more than 12 weeks. Animals that produce only one or a few colonies on prolonged incubation, obviously are the least likely to spread the infection to susceptible animals. Most of the heavily infected animals can be identified immediately by rectal biopsy and microscopic examination, but the intermediate and light shedders are best identified by culture.

c. Chemical tests:

Chemical detection of the organisms in fecal specimens was discussed, but the state of the art still is far short of the sensitivity and sophistication of culture of the organisms, even though it has the advantage of more rapid detection of the organisms if they are present in sufficiently high numbers.

Recent advances in culture techniques have made it feasible to use fecal cultural isolation as a reliable method of detecting shedders. It still is a slow diagnostic procedure, but the producer who wants to eliminate the disease now can have whole herd tests done on fecal specimens which he can collect and submit either to state diagnostic laboratories or to private laboratories to determine which animals are shedding and are a threat to his calves.

The reverse side is that the newly developed ELISA and RIA tests can be used to detect animals that are or have been infected, whether or not they will become shedders. The producer that has ELISA or RIA reactors can use the information to make rational decisions when culling, and the buyer can use the information when deciding where to buy replacement animals.
Vaccination—A paratuberculosis bacterin has been approved for use on a very restricted basis in a number of states and a similar bacterin is used in a number of other countries. It was clear from the results presented at the Colloquium that the bacterin will not eliminate the disease, but it will reduce mortality. In the U.S., most states that have approved the use of the bacterin have followed the “Wisconsin Plan.” The Wisconsin Plan is a vaccination and husbandry program which will control the disease, whether the vaccine is used or not. The vaccine reduces both the clinical incidence and the numbers of infected animals, but its most important impact is more of a placebo effect. To be able to use the bacterin, the producer is required to modify his management procedures to eliminate infection of the calves. After calfhood infection is eliminated and the animals are raised in separate non-contaminated quarters, the disease eventually disappears whether the animals have been vaccinated or not. A major negative aspect of vaccination is that it causes some of the animals to become tuberculin reactors and to become positive on serologic tests for paratuberculosis.

Effects of dietary iron—Studies of the effect of intracellular iron storage or prolonged elevation of dietary iron on the pathogenesis of paratuberculosis were conducted in paratuberculous cattle and mice. No significant effect due to elevated iron could be demonstrated, but in 25 cattle showing early, preclinical granulomatous enteropathy of Johne’s disease, catarrhal enteritis and mast cell reactivity was still marked in the duodenum and anterior and mid-ileum. Granulomatous change, mainly in posterior ileum and ileo-cecal valve, was associated with siderosis of macrophages containing mycobacteria in 28% of the animals. Highest mycobacterial indices occurred in the siderotic ileo-cecal granulomas. In cattle with clinical signs of Johne’s disease, granulomatous lesions extended further up and down the tract from the ileo-cecal valve, and catarrhal enteritis persisted only in conjunction with mast cell reactivity in upper portions of the tract. Histopathological results obtained from parasite-free cattle confirmed that mast cell-mediated upper tract enteropathy also is likely to be an important feature of early Johne’s disease, which classically is recognized as granulomatous change in the lower region of the ileum.

Related mycobacterial diseases—Several other mycobacterial diseases similar to M. paratuberculosis infections were discussed at the Colloquium. One was infection with the “wood-pigeon bacillus.” This organism has been isolated repeatedly from wood-pigeons in Europe. It is mycobactin dependent, and when fed to calves it is progressive and causes clinical Johne’s disease. The other mycobactin dependent organism related to M. paratuberculosis that was discussed has been isolated from human patients with Crohn’s disease. This disease causes symptoms in humans that are very similar to Johne’s disease in ruminants, except that the organisms are not demonstrable by acid-fast staining of the diseased intestinal tissue. Like animals with paratuberculosis, most Crohn’s disease patients have antibodies against M. paratuberculosis antigens, but react to tu-
bacillus PPD less frequently than the general population. When the organisms from Crohn’s disease patients were fed to goats, a progressive intestinal infection, with fecal shedding of the organisms ensued. The three organisms, *M. paratuberculosis*, the wood-pigeon bacillus, and the Crohn’s disease bacillus, can be distinguished by drug sensitivity tests, but they are very similar, and more closely related to one another than they are to any other species. The principal differences between these organisms and mycobactin dependent *M. avium* strains are generation time, drug sensitivities, and serologic properties.

The clinical signs, pathology, and an evaluation of some diagnostic tests for paratuberculosis in North American wild ruminants were reported.

Chemotherapeutic agents—Antimycobacterial compounds have been tried by several investigators in attempts to try to eliminate paratuberculosis infection. Ten or 12 years ago, we tried treatment of clinically ill cows with Clofazimine, an antileprosy drug. Since then, we have done innumerable in vitro tests with well over 100 antimycobacterial compounds. Many of these agents have antimycobacterial activity against *M. paratuberculosis* in vitro, but when tested in vivo, have no demonstrable activity. *M. paratuberculosis* lives within macrophages in the lamina propria and mesenteric lymph nodes, apparently dependent on its host’s metabolism for everything not unique to its own system. Thereby, it is not highly antigenic and it is not sensitive to most of the antimycobacterial drugs available.

Amikacin sulfate reduced the numbers of organisms being shed within one month trial periods, but it was extremely expensive. Clofazimine essentially eliminated shedding and is being continued on several animals under test. However, at this time, clofazimine is not approved for use in the United States. Whether or not effective anti-*M. paratuberculosis* drugs are found, the normal producer will have to depend on preventing infection rather than treating it. Only an occasional very valuable animal (based either on dollar value or on sentimental value) will warrant drug treatment.

Management recommendations—The principal management recommendations for eliminating the disease in infected herds that were considered necessary, were relatively inexpensive to implement, and are as follows.

1. Segregate calves and adult animals. Never let calves inhabit any of the same premises that have been or are being inhabited by adult animals. General hospital enclosures where sick adult cattle and parturient cows inhabit the same enclosures should not be used.

2. Feed pasteurized colostrum or colostrum from ELISA negative animals. Thereafter, use commercial milk replacer, or at least owner produced milk that has been pasteurized. One-half hour at 60 C (140 F) or five minutes at 65 C (149 F) will kill any *M. paratuberculosis* in milk obtained after thoroughly cleansing and stripping the teats before milking.
3. For beef animals, where bucket feeding usually is deemed inappropriate, postpone breeding dates so that the calves can be delivered on noncontaminated pasture rather than in a contaminated barn.

4. Whether or not the animals in the buyer's herd are infected, he should make every attempt to purchase noninfected animals as replacement animals. To achieve this, he should purchase animals only from herds with "paratuberculosis-free-status" determined by three fecal culture examinations of the entire adult herd at 6- or 12-month intervals, or by ELISA tests of the adult herd. Absolute disease free status of an individual animal cannot be assured by any existing tests, but both the whole herd fecal tests and whole herd ELISA tests are sensitive enough to provide a high level of assurance that when all of the animals from those herds are tested and found negative, the herds most likely are not infected.

5. After a herd is determined to be infected, it cannot be assured to be disease free until all animals exposed to the organisms when young have been removed. Neither vaccination of calves, nor fecal or serologic tests of adults can assure that animals born and exposed to the organisms before the more stringent management practices were implemented, will be disease free. Any young animals exposed to the organisms, whether vaccinated or not, have a potential to become shedders and to disseminate the disease to other young animals.

In summary, the more sensitive and specific serologic tests now available can detect most of the infected animals in a non-vaccinated herd. Its paratuberculous status should first be established by fecal culture, but thereafter, serologic determination of individual animals should be used to help in the herd management. Serologically identified animals should be the first to be eliminated when culling excess animals. The gel diffusion precipitin test usually identifies animals that currently are shedding the organisms. The ELISA or RIA tests more frequently can identify animals before their bacterial load is high enough to be detected by fecal culture. Among vaccinated animals, only fecal culture can be used to identify shedders.

My analysis of the Colloquium is that highly sensitive tests for the control of paratuberculosis are available. Fecal culture tests can be used both for qualifying a herd to be disease free and to monitor the progress of the infection within a herd. The AGID test can be used as a "quick-and-dirty" test to get rid of the heavy fecal shedders, especially the apparently clinically ill cattle, without waiting for fecal culture results. In addition, the AGID would be an inexpensive way to use serum samples obtained for brucellosis testing of cull cows to determine which herds in a state had paratuberculosis. The ELISA can be used to get rid of animals before they start shedding. Whole herd fecal culture, ELISA, RIA, CF, or AGID tests can be demanded before purchasing animals.

As a result of the recent Colloquium, I expect most importing countries to begin demanding evidence of negative fecal culture of the whole herd of
origin, as well as negative ELISA tests on the individual animals to be imported. The ELISA tests reported at the Colloquium were quite sensitive and many of them had eliminated false positive reactions as a major problem. The use of highly specific antigens, along with absorption of the test sera to remove nonspecific antibodies have resulted in serologic tests with very few false positive reactions.

There was a general sense of relief among the producers and regulatory officials present that paratuberculosis finally has been recognized as the major economic problem that it is and has been brought into the open.
Status of the State-Federal Tuberculosis Eradication Program Fiscal Year 1983

Ralph L. Hosker—DVM

In Fiscal Year 1982, 11 herds were found geographically in the four corners of the continental United States. This year, FY 1983, 14 herds were grouped with five in the North Central United States, seven in the South Central States, and one herd each in our territorial extremes. These herds were located in the following States: Wisconsin, Texas, Louisiana, Arkansas, Mississippi, Tennessee, Puerto Rico, and Hawaii.

Some areas of occurrence were not unexpected, whereas others were almost shocking. The following is a brief commentary on these herds. Puerto Rico, with one infected herd this fiscal year, has had tuberculous herds in recent years and over a long period of time. Hawaii, with one infected herd this fiscal year, has rough terrain in its pasture operations and it has been difficult to gather herds for test. The present infected herd is on Molokai Island, Hawaii, where the most recent herd depopulation was in FY 1981. There is a long history of tuberculosis on this island, and there have been isolations of *M. bovis* from feral swine and deer.

The beef herd in Arkansas slumbered for almost 10 years following exposure by purchase of animals from a previously infected herd. The infected herd found in Mississippi was an expanding dairy operation which had purchased large numbers of animals, as well as having leased cattle on the premises. A small herd detected in Tennessee was exposed through purchase of calves out of the Mississippi herd.

The area in southern Louisiana, where two herds were detected this fiscal year, is a marshy coastal plain. Herds commonly have multiple ownership, and there are frequent movements of cattle as grazing conditions change through the year. Southern Louisiana has a long history of infected herds.

The disclosure of two herds in Texas points to the risk of disease introduction from outside of the United States. The first herd is a beef operation found earlier this fiscal year, and the source of infection has not been established. It may have been some older Charolais cattle no longer in the herd. However, this herd was in a county that borders Mexico. There have been occurrences of accidental entry of grazing livestock from Mexico. When this happens, these animals are usually driven back or confined pending disposition. Tuberculosis was confirmed early this fiscal year from a cow that was slaughtered in California after being impounded by an animal control agency. The second herd is a dairy operation located near El Paso. It has been placed under “constructive seizure” by the U.S. Customs Service on suspicion of smuggling of animals.

A significant event to ponder is the disclosure of tuberculous herds in the North Central part of the United States in the State of Wisconsin. This State became Tuberculosis Accredited-Free in 1980. On May 13, 1983, a
lesion suspicious of tuberculosis was found in a regular kill slaughter animal. Investigation and testing of herds to date has found infection in five herds. Spread of infection by animal movements and confirmations of *M. bovis* have caused the removal of Wisconsin's Tuberculosis Accredited-Free State status.

It should also be noted that in FY 1981 and FY 1982 tuberculosis was found in two other Tuberculosis Accredited-Free States. These States were Vermont in FY 1981 and New York in FY 1982. In each of these States, there was one tuberculous herd found and no evidence of spread. Therefore, their status did not change. Once again, tuberculosis has shown itself to be no respecter of geographic location or program status. Final eradication will come as the result of increased surveillance, relentless pursuit of epidemiological information, and thorough investigations of suspected herds.

**Figure 1**—In FY 1983, two States became Tuberculosis Accredited-Free. These were South Dakota on November 1, 1982, and Delaware on January 6, 1983. Wisconsin returned to Modified Accredited State status on October 1, 1983. There was a net gain of one State. This brings the total number of States Tuberculosis Accredited-Free to 23. These States are as follows: Arizona, Colorado, Connecticut, Delaware, Maine, Maryland, Michigan, Minnesota, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Rhode Island, South Carolina, South Dakota, Utah, Vermont, Virginia, Wyoming, plus the U.S. Virgin Islands.

Four states have been added to those that have not experienced tuberculosis in over 5 years. They are: Idaho, Kansas, Missouri, and Massachusetts. There are a total of nine such States. Out of eight States designated in FY 1982, South Dakota and Delaware have become Tuberculosis Accredited-Free States and Mississippi had an infected herd. Lack of dealer laws or licensing, and the required recordkeeping systems have prevented some States from achieving Tuberculosis Accredited-Free status.

**Figure 2**—Thirteen infected herds were located this fiscal year in the following States: Wisconsin with five; Texas with two; Louisiana with two: and Hawaii, Arkansas, Mississippi, and the Commonwealth of Puerto Rico with one each. There was also one exposed herd in Tennessee.

**Figure 3**—This simple pie graph illustrates the importance of traceback from regular kill slaughter animals which accounted for 9 of 14 herds located. Tracing from infected herds identified four infected herds in Wisconsin and one exposed herd in Tennessee. There were no herds found this year through reactors to routine herd tests. Although in the Puerto Rico herd, testing did identify a suspect that located a herd through slaughter sample collection.

**Figure 4**—This graph shows the location of 14 tuberculous herds found through epidemiological tracing, and for the first time in over 10 years that no herds were located as a direct result of routine or regular testing in herds.
Figure 5—Complete depopulation was carried out in 12, or 86 percent, of the herds detected in FY 1983. Two herds, or 14 percent, were not depopulated this fiscal year. They are: (1) a dairy herd near El Paso, Texas, with approximately 300 head, and (2) a beef herd on Molokai Island, Hawaii, with approximately 8,000 head.

In looking at this graph from Fiscal Year 1979 to the present, it indicates that 11 herds were not depopulated. The actual count is nine. Depopulation did take place in 1981 of a herd that appeared in the statistics of 1979 and 1980. Herds that are not depopulated are placed under surveillance and testing for 5 additional years as “high risk herds” following release from quarantine.

The total high risk herd list is considerably larger or approximately 30 herds. This list contains herds that have been depopulated and then repopulated, and herds that have not completed testing on schedule, in addition to the nine herds previously mentioned. In the case when herds were depopulated and then repopulated, they are tested for two years.

Figure 6—This map shows the proportion of herds depopulated in the various States; and the two herds, one in Hawaii and one in Texas that were not depopulated this fiscal year.

Figure 7—These two graphs illustrate the success rate of completing slaughter traceback investigations of 27 confirmed *M. bovis* isolations from regular kill animals. In the first graph, there was a total of 19 animals not identified at slaughter. The success rate of tracing these animals was only 10 percent. In the second graph, there was a total of 8 animals slaughtered with identification. The success rate of tracing these animals was 75 percent. In comparing these two graphs, it strongly shows that recording of identification and the collection of identification devices from animals does make a tremendous difference in the success rate of investigations.

Figure 8—There was a significant decrease in the total number of slaughter sample submissions this fiscal year. There were 1,578 submissions in FY 1983 compared to 1,895 submissions in FY 1982. The decrease was primarily from slaughter plants that kill fed cattle. Some fat kill plants are working more shifts and killing greater numbers of cattle because they have moved closer to feedlot sources. There has been newhirings and relocation of inspection personnel to meet these needs. Total slaughter in the United States has remained approximately the same this year as last year (35 million cattle and calves inspected). The graph indicates a somewhat higher percent of adult animals sampled. That is 60 percent of 1,578 submissions for FY 1983 as compared to 48 percent of 1,895 submissions in FY 1982.

Figure 9—The bar graphs in this figure again illustrate the decreased number of slaughter collections when tabulated by investigations completed and closed for a total of 1,711 cases. Bovine tuberculosis was found in 27 cases of which 10 isolations were from adult cattle and 17 were from fat cattle. Eleven of the fed cattle were of Mexican origin that were imported as feeders. Last year there was a total of 78 *M. bovis* isolations.
Out of the 78 isolations, 75 were from fat cattle and 38 of these were documented as having originated from Mexico.

This year's 14 tuberculous herds represents an increase over each of the previous 3 years and from the all time low of six herds in FY 1980. The discovery of these herds is a testimonial to the value of epidemiological tracing and the ever increasing dependence of the surveillance effort on traceback from regular kill slaughter animals. There is need for special areas testing of herds in some States. There can be no relaxation in the search for bovine tuberculosis. All States are essentially in one large community “AT RISK” until eradication is accomplished.
Tuberculosis Eradication

Methods of Locating 14 Tuberculous Herds Initially Detected during FY-83

- Traceback of Regular Kill Slaughter Animals (9)
- Tracing Exposed Cattle from Affected Herds (5)
Tuberculosis Eradication

Detecting Herds with TB Infection: 1973 through 1983

All Other Tuberculin Testing

Epidemiologic Tracing

1973 74 75 76 77 78 79 80 81 82 83
Tuberculosis Eradication

Location of 14 Tuberculous Herds
FY 1983
Tuberculosis Eradication

Bovine Tuberculosis Area Status

September 30, 1983

Accredited Free States (23) plus Virgin Islands

Modified Accredited Areas (27) plus Puerto Rico

No M. Bovis for Over 5 Years (9)
Tuberculosis Eradication

Number of 6-35's Submitted FY 83 (Federal Establishments)

Number of 6-35's Submitted
Number of Adult Animals
Number of Animals with Identification

Number of ID Devices Submitted


1,578
942 (60%)
663 (70%)
327 (49%)
Tuberculosis Eradication

Traceback of 27 Tuberculous Cases
(Regular Kill Animals) FY 1983

19 Unidentified

90% Unsuccessful

10% Successful

8 Identified

25% Unsuccessful

75% Successful
Tuberculosis Eradication

Herds Found vs. Herds Depopulated
FY 1973-83

Herds Found

Herds Depopulated
Tuberculosis Eradication

Proportion of Tuberculous Herds Depopulated

FY 1983

[Map showing the proportion of tuberculous herds depopulated in FY 1983 across the United States.]
Tuberculosis Eradication

Tuberculosis Traceback Investigations
(Regular Kill)

FY 1983 (Cases Closed)

Cases not tuberculosis
Cases of tuberculosis


Fiscal Year

1042 1487 1461 1516 1890 1741 1849 1894 2022 1711

195 195 167 58 65 62 52 53 78 27


FISCAL YEAR 1983
REPORT OF THE COMMITTEE ON TUBERCULOSIS AND JOHNE'S DISEASE

Chairman: Sarah Hurley, Madison, WI
Vice Chairman: V.P. LaBranche, Boston, MA

J. A. Acree, FL; Don Agresti, CA; L. R. Barnes, IN; C. E. Boyd, SC; J. M. Dick, PA; M. A. Essey, CA; J. G. Flint, MN; G. H. Frye, MD; Stanley Harris, IA; Elmer Himes, IA; G. F. Hoffsis, OH; R. L. Hosker, MD; D. E. Hughes, SD; C. A. Lamb, CA; L. L. Larson, WI; A. R. McLaughlin, WI; R. S. Merkal, IA; D. J. Myers, CANADA; W. J. Owen, IA; William Searles, TX; M. S. Silberman, GA; D. H. Smith, WA; P. L. Smith, CA; G. R. Snyder, VA; P. L. Spencer, IL; C. D. Stumpff, KS; C. O. Thoen, IA; Bruce Widger, NY; E. J. Wilson, MD

Meeting: Sahara Hotel—Tuesday and Wednesday, October 18 and 19, 1983 1:30 p.m.—Room 6a

Twenty-two Committee members and fourteen guests were present for all or part of the committee meetings.

The following reports were presented and discussed and will appear in their entirety in the Proceedings:

1. Comparison of ELISA Reactions and Tuberculin Skin Responses in Elk (Cervus elaphus) in a Herd in which M. bovis was previously diagnosed.
   Katherine Swartz, Iowa State University

2. Isolation of Mycobacteria from California Slaughter Swine
   D. W. Hird, University of California

3. Epidemiological Study of Outbreak of Bovine Tuberculosis in a Mississippi Dairy Herd—
   C. D. Stumpff, APHIS-VS

Several subcommittees submitted reports for approval.

A. The Swine Mycobacteriosis subcommittee report was submitted by G. H. Frye. The subcommittee held no meetings during the past year. John Brown has initiated a swine mycobacteriosis research project which is nearing completion. Veterinary Services has contributed the expertise of Janet Payeur until the end of this year. An attempt is being made to schedule a meeting to discuss the topic with CDC, FSIS, VS, and other interested parties. This meeting will be scheduled after the recently compiled literature review on swine mycobacteriosis has been returned by the reviewers.

B. The subcommittee report on Tuberculosis in Steers of Mexican Origin was presented by M. A. Essey. The report is included in the text of the Proceedings, however, there was a recommendation and a resolution presented to the Committee for consideration.
**Recommended:** That the Tuberculosis and Johne’s disease Committee go on record as supporting a cooperative agreement between the United States and Mexico to enter into a joint effort that would lead eventually to the eradication of bovine tuberculosis from the country of Mexico.

**Approved:** by the Committee as read.

C. The subcommittee report on Johne’s Disease was given by R. S. Merkal. The subcommittee met at 7 p.m. on Tuesday, October 18, with 5 members in attendance.

**Items discussed—**

1. Report by R. Jones, Colorado, on development of Sandwich ELISA for detecting M. paratuberculosis in fecal specimens. (The technique uses biotin coated tertiary AB, then peroxidase labeled avidin as a binder. Claims sensitivity of $10^4$—$10^5$ organisms/g with culture spiked samples. Sheep (naturally infected) antibody on cuvettes + test suspension and rabbit anti-whole M. Paratuberculosis sheep sera 1:100 to 1:200—uses chloroform extract of fecal.)

2. Problem of producers using other lab’s serologic or culture testing to have a “clean” herd at time of official test to try to get “documented paratuberculosis free” status.

3. Possibility of using AGID on sera collected for Bangs tests at slaughter of cull cattle or to use it to select cattle quickly for the proposed 10% cutback in livestock.

4. Methods for establishing a nationwide method of control were discussed.

**Suggestions offered were:** a. Suggest that each state be urged to set up a program somewhat similar to the “Wisconsin Plan.” b. That the National Breed Associations set up a test and identification plan to identify “Documented Paratuberculosis free” herds. There was commendation of the Iowa Guernsey Breeders Association plan to identify “Paratuberculosis free” herds and the National Guernsey Breeders Plan to follow that lead.

5. Discussed possibility of Breed Associations requiring “documented paratuberculosis free” status to be able to show cattle, etc.

6. The necessary interaction of federal and state officials and Breed Associations was discussed and seemed to be assured by those present.

7. The recent development of private laboratories designed to culture and to use recently developed serologic techniques for detection of paratuberculous animals on a fee basis for producers led to a lot of discussion concerning whether their results should be reported to the state of origin of the specimens and how their competency to conduct the tests should be verified. The prevalent opinion was that such labs should be “ordained” by the National Veterinary Services Lab in Ames as have the various state labs in the past.
8. It was felt by most members that a Federal program on Paratuberculosis Control should be established to allow funding of the Federal regulatory responsibility. USDA has not in the past had a paratuberculosis program. The work done by NVSL and other Federal regulatory personnel has been under the auspices of the Tuberculosis Eradication Program. It now is recognized that paratuberculosis is a more economically important disease than is tuberculosis, or probably even Brucellosis, and that there should be a "Paratuberculosis Control Program" at the Federal level, with funding to support the activities that Federal officials need to conduct. These include verification of state and private diagnostic labs, monitoring capability, etc.

The problem of getting good information to producers, practitioners, breed associations, and state/federal regulatory officials was discussed. It was felt that the prime group of individuals who should receive this information are the producers, who will have the most influence with state and federal legislatures. Perhaps this funding could come from the Paratuberculosis Control Funding.

The discussions were long and wearing, but the following recommendations were arrived at:

1. The Johne's disease subcommittee should be elevated to the status within USAHA of "Paratuberculosis Committee", rather than a subunit of the Tuberculosis and Johne's disease committee, since paratuberculosis is economically, for the producer, a far more important and significant disease than is tuberculosis.

2. All laboratories testing for paratuberculosis should be required to send the results of those tests to Animal Health officials within the state of origin, upon the request of the state of origin.

3. A National Paratuberculosis Program should be established to allow funding of APHIS-NVSL programs for verification of laboratories and to do the cross-checking, culturing, and field work that is necessary; rather than have it being done surreptitiously as part of the TB program.

4. Paratuberculosis should remain as a priority item in the USDA special grants section.

After some discussion, the full Tuberculosis and Johnes Disease Committee decided to reject the recommendation#1, but to elevate the status of Johnes Disease within the committee to an equal level with tuberculosis and to devote an amount of time and attention to Johnes's disease proportionate to its importance.

The subcommittee report was then approved as amended.

D. The subcommittee report on the Uniform Methods and Rules by Dr. Ralph Hosker, APHIS, VS

The following changes of the UM&R were proposed.
Part I—Definitions (Change #2)

The proposed changes to the following two definitions would reaffirm the use of the comparative-cervical (C-C) test in responding animals of unknown status and would state the use of the C-C test in retesting of goats.

**Negative animals**—Any cattle or dairy goats which show no response to a tuberculin test or have been classified negative following the application of the comparative cervical test.

**Suspect**—Any cattle or dairy goats which show a response to the caudal fold tuberculin test and are not classified as a reactor or cattle or dairy goats which have been classified suspects by a comparative cervical test.

A motion was made to accept this change. It was seconded and passed.

Part I—Definitions (Change #3)

It has been proposed that the present definitions for the official tuberculin test be made more explicit by adding the following which is underscored:

**Official Tuberculin Test**—A test for tuberculosis applied and reported by approved personnel in accordance with these Uniform Methods and Rules. The official tuberculin tests are: the caudal fold test, the comparative cervical (C-C) test, and the single cervical test.

A motion was made to accept this change seconded and passed.

Part II—Recommended procedures (Change #1)

It has been proposed that the designation of supplemental and diagnostic tests is unclear as presently stated in part II—Recommended procedures, D. Primary diagnostic test, and E. Secondary supplemental test.

The following format is suggested. New terms and definitions are underscored twice. Should these changes be accepted they would be D, DA, and E.

D. Presumptive diagnostic test

1. **Caudal fold test**—this is the official tuberculin test for routine use in individual cattle, dairy goats, and herds of such animals where the tuberculosis status of these animals is unknown.

A motion to accept this change was made, seconded and passed.

D. Supplemental diagnostic test

1. **Comparative-cervical test (C-C test)**—This is the official test for retesting of suspects. It shall be applied only by a full-time state or federal regulatory veterinarian and shall not be used in known infected herds without the prior written consent of cooperating state-federal officials. The C-C test shall not be used as a primary test for animals of unknown status.

A motion to accept this change was made and seconded and passed.

E. Primary diagnostic test
1. **Single cervical test**—This is the recommended test for use in herds affected with bovine tuberculosis and testing exposed cattle from such herds. It shall be applied only by a veterinarian employed in full-time capacity by the state or federal government.

2. **Caudal fold test**—This is a primary diagnostic test when used in herds affected with bovine tuberculosis in lieu of the single cervical test. It shall be applied only by a veterinarian employed in full-time capacity by the state or federal government. Responses shall warrant the reactor classification.

A motion was made, seconded, and passed to accept these changes.

**Part II—Recommended Procedures (Change #4)**

It is proposed that the section that deals with S. "Dealer registration and record keeping" should have a sentence added at the end of the introductory paragraph. This sentence would read as follows.

*S. Dealer registration recordkeeping—Any dealer who purchases, deals in, or sells cattle; who acts as a commission representative or broker, or who operates and conducts an auction where cattle are sold must be registered or licensed with the appropriate state agency and maintain required records which will facilitate traceback of affected, exposed, or reactor animals by state authorities to the herd of origin or other point of original infection. Dealer registration (or licensing) and maintenance of dealer records shall be required of accredited-free states.*

A motion to accept this was made, seconded and passed.

**Part III. Herd and state status plans (Change #1)**

It has been proposed to reduce the time interval required for reinstatement of accredited-free status when tuberculosis has been found in two or more cattle herds in a tuberculosis free state within a 48-month period.

Disclosure of two or more tuberculosis herds in a state within any consecutive 48-month period will be cause for revocation of the state’s accredited free status. Reinstatement of accredited free status will require a 5-year period of freedom from evidence of tuberculosis and full compliance with these uniform methods and rules. If all tuberculosis herds are depopulated in such a state, a lesser period of time or 2 years of freedom from evidence of tuberculosis and full compliance with the UM&R will be required for reinstatement.

**Part III. Herd and state status plans (Change #2)**

It has been proposed to increase the testing age of goats for accreditation, re-accreditation, and additions to herds from a modified accredited free state, from 6 months of age to 12 months. The proposed changes are underscored.

B. Accredited herd plan.

1. **Animals to be tested**—Testing of herds for accreditation or re-accreditation shall include all goats over 12 months of age. All

*Report was accepted with the deletion of Section S.*
natural additions shall be individually identified and recorded on the test charts as members of the herd at the time of the annual test.

2. **Additions**—Herd additions must originate directly from one of the following:
   
a. Accredited herd
   
b. Herd in a modified accredited state that has passed a herd test of all animals over 12 months of age, and the individual animals for addition were negative to the tuberculin test conducted within 60 days.

The Committee also considered a question asked by Harold McCoy, APHIS, VS, concerning the implications and potential for spread of tuberculosis through the preservation and/or transfer of embryos from animals in an infected herd. After some discussion of the limited amount of information available, the Committee approved a motion to appoint Drs. A. R. McLaughlin and L. L. Larson, both from Wisconsin, to interact with the Import-Export committee's sub-committee on embryo transfers. They will report at next year's committee meeting.

The committee also considered a proposal to either enforce, amend, or delete Part 71 of 9 CFR concerning the movement of cattle exposed to infectious disease—including Johne's disease. A motion was approved to appoint Dr. R. L. Hosker, APHIS, VS; and G. Hoffsis, OH; to assist the effort in APHIS which has already begun to revise Part 71.

The report was approved by the Executive Committee with the deletion of the part dealing with S.

The meeting was adjourned at 5 p.m. Oct. 19, 1983
VESICULAR STOMATITIS IN PRONGHORN ANTELOPE: SEROLOGIC SURVEY AND ARTIFICIAL INFECTION

E. Tom Thorne,* Elizabeth S. Williams,** William J. Adrian*** and Cathy M. Gillin*

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INTRODUCTION

Vesicular stomatitis (VS), a vesicular disease of domestic livestock, is caused by 2 serotypes, New Jersey and Indiana, of vesicular stomatitis virus (VSV). The disease is endemic in parts of South, Central and southern North America with periodic epizootics involving Appalachia, the Upper Mississippi Valley and the Rocky Mountain region (1-3). In the southern United States, VS is enzootic in the southern Atlantic and gulf coastal plains from North Carolina to Louisiana (2). The most recent epizootic occurred in the summer of 1982, and cases in livestock were reported from most western states (4).

Mechanisms of transmission of VS are poorly understood. Direct contact between susceptible and infected animals may be important. Epizootics occur during warm weather, when biting insects are abundant, and usually cease after killing frosts. This suggests arthropod transmission and VSV, New Jersey serotype has been isolated from Simulium black flies (5) and Hippelates pusio eye gnats (6). Vesicular stomatitis virus, Indiana serotype has been found in Phlebotomus midges (7) and mosquitoes (6,8).

Vesicular stomatitis in domestic livestock is characterized by a short incubation period, a febrile response and development of vesicles on the tongue, muzzle, gums, feet and/or teats. Vesicular development does not always take place (9) and progression to erosions and ulcerations occurs rapidly. Clinical signs include transient fever, depression, drooling, weight-loss and, generally, uneventful recovery. Sloughing of the hooves and death rarely occur (1).

The natural reservoir(s) of VSV are presently unknown. Antibodies to VSV have been identified in a wide variety of wild mammals (10-16) and in wild turkeys (17). The occurrence of antibodies in white-tailed deer (10,15) and the possible occurrence of spontaneous clinical cases in deer in the southeast United States prompted experimental infection of white-tailed deer with VSV (11). Four of 5 experimentally inoculated deer were clinically affected, the 5th having only subclinical infection. One mule deer of 78 from New Mexico had antibodies against New Jersey type VSV in 1977 (16).
Vesicular stomatitis was not diagnosed in wild species during the 1982 epizootic, although there were unconfirmed reports of VS-like signs in wild animals (18). The occurrence of vesicular stomatitis in cattle and horses, which frequently share range with pronghorn antelope in Wyoming and Colorado, raised questions about the susceptibility of pronghorn to VSV. To answer this question a serologic survey of pronghorn was undertaken in Colorado and artificial infections were conducted in Wyoming.

MATERIALS AND METHODS

In September 1982, sera were collected from hunter-killed pronghorn near Craig, Colorado using special mailer kits (19). Suitable sera were screened at a final dilution of 1:20 by a VSV plaque reduction neutralization test for both VSV New Jersey (Hazelhurst) and VSV Indiana (Lab strain).a

Two pronghorn, a yearling and a mature pregnant Doe, from the Wyoming Game and Fish Department Sybille Wildlife Research Unit were available for study; both had been hand-raised and were well adjusted to confinement and restraint. Artificial inoculations were conducted at the isolation facilities of the Wyoming Veterinary Medical Research Center, Division of Microbiology and Veterinary Medicine, University of Wyoming, Laramie. Inoculum was 4th bovine passage of New Jersey strain VSV originally isolated in 1982 from a bovine in Colorado and obtained from National Veterinary Services Laboratory.b Each animal was inoculated intradermally in 5 cm sites in the dorsum of the tongue under etorphinec and xylazined anesthesia. The Doe received a total of 1.2 ml and the yearling 1.4 ml of inoculum containing \(10^6\) ID\(_{50}/\text{ml}\) virus. Antelope were observed twice each day for clinical signs. Seventy-two hours post-inoculation, the animals were immobilized again for detailed examination of the oral mucosa, teats and feet; for collection of lingual epithelium, whole blood and sera for virus isolation; and biopsies were obtained for histopathology. The pronghorn were bled frequently for serologic tests until death; thorough necropsies were conducted.

Virus isolations were conducted at National Veterinary Services Laboratory.c Tissue suspensions were inoculated onto embryonic porcine kidney and embryonic bovine kidney Leighton tube cell cultures. When cytopathic effects were observed, cultures were stained with New Jersey and Indiana VSV fluorescent antibody conjugates. Sera were tested for VSV New Jersey by complement-fixation and serum neutralization tests and for VSV Indiana by serum neutralization procedures. A neutralization titer of \(\geq 1:32\) was considered indicative of exposure to VSV.

RESULTS

One hundred thirty-nine suitable sera were obtained from hunter killed

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a Dr. Pat Webb, Centers for Disease Control, Fort Collins, Colorado 80521.
b Dr. E. W. Jenney.
d Rompun, Haver Lockhart, Shawnee, Kansas 66201.
pronghorn (Table 1); 83 (60%) were positive at $\geq 1:20$ to VSV New Jersey serotype by the plaque reduction neutralization test. Of these 20 (14%) were also positive at $\geq 1:20$ to VSV Indiana. Only two samples were positive to VSV Indiana alone.

One experimentally inoculated pronghorn, the adult doe, developed clinical signs of vesicular stomatitis. Signs observed in the doe began on the second day postinoculation with licking of the lips and a serous nasal discharge. By the 3rd day postinoculation when the doe was examined under anesthesia, the mucosa of the dorsum of the tongue was blanched, edematous and sloughing, and there were erosions along the sides of the tongue. On the 4th through the 10th day, the disease was characterized by licking of the lips, hypersalivation, anorexia, fever (up to 40.3°C) and depression. The doe began coughing, although she was beginning to take food, and her general condition was improving. At 12 days postinoculation she died of apparent aspiration pneumonia.

The yearling doe had no lesions when examined 72 hours postinoculation. On the 4th day she was slightly depressed and had a fever of 40.5°C but showed no other clinical signs of VS. On day 32 postinoculation, she was euthanized because of chronic diarrhea unrelated to VS.

Biopsy specimens collected from both pronghorn on day 3 postinoculation were examined microscopically. Tongue mucosa of the doe, which had lesions at the time of biopsy collection, was characterized by widespread epithelial necrosis and intercellular edema. Vesicle formation was not apparent. The subepithelial tissue was infiltrated by neutrophils. The biopsy from the yearling’s tongue was essentially normal.

New Jersey serotype VSV was isolated from a specimen of tongue collected from the adult doe 3 days postinoculation. Virus was not isolated from blood collected three days postinoculation or from cheek, tongue, lung or fetal tissues collected at death, 12 days postinoculation. Tongue mucosa obtained from the yearling doe 3 days postinoculation was negative for VSV.

Complement fixation tests on all pronghorn sera were anti-complementary or produced nonspecific results (Table 2). On the neutralization test to the New Jersey strain, the doe was negative at the 1:8 dilution preinoculation and 72 hours postinoculation but was positive at 1:64 on the 5th day (Figure 1). On the 8th day and 10th day the doe reacted at $> 1:256$ dilution. The yearling remained negative until the 8th day postinoculation when she was positive at 1:64, that titer was maintained 15 days and had declined to 1:32 by the 31st day. All neutralization tests to the Indiana strain were negative at 1:8 except the doe on the 10th day postinoculation when she reacted at 1:32 against Indiana and $> 1:256$ to New Jersey VSV.

**DISCUSSION**

The survey of hunter-killed pronghorn from Colorado produced serologic results on...
evidence of pronghorn involvement in the 1982 VS epizootic. Most animals showed reactivity to New Jersey strain VSV which correctly reflected the involvement of this strain in the 1982 outbreak. The 14% positive response to VSV Indiana probably is the result of cross-reactivities.

Although the experimental infection study involved only 2 animals, it did show that pronghorn are susceptible to VSV and that some infected animals may be seriously affected while in others the infection is mild and inapparent. The clinical signs and gross and microscopic lesions in the adult doe were similar to those described in domestic species (1) and deer (2); however, death associated with VS is considered unusual in these species.

The effect of pregnancy on the infection in the adult doe cannot be assessed from this small trial; however, under natural conditions pronghorn would be unlikely to be infected while pregnant.

Serum neutralization test responses of experimentally inoculated pronghorn showed a significant rise in titer to VSV New Jersey serotype by 3 to 8 days postinoculation and, in one case, maintenance of a significant titer for at least 31 days. National Veterinary Services Laboratory regards a neutralization titer of \( \geq 1:32 \) as significant and this study tends to corroborate that conclusion in pronghorn. Cross reactivity between VSV New Jersey and VSV Indiana was demonstrated in the doe on day 10 when titers were \( > 1:256 \) and \( 1:32 \) respectively. The complement fixation procedure was unsuitable for testing pronghorn sera for VSV antibodies.

This study was sponsored by United States Fish and Wildlife Service Pittman-Robertson Federal Aid to Wildlife Restoration, the Wyoming Game and Fish Department, the Division of Microbiology and Veterinary Medicine, University of Wyoming and the Colorado Division of Wildlife. Technical advice, virus inoculum and laboratory support were provided by United States Department of Agriculture, National Veterinary Services Laboratory.

**REFERENCES**


Figure 1. Vesicular stomatitis, New Jersey and Indiana, virus serum neutralization titers in 2 artificially infected pronghorn antelope.
Table 1. Serologic survey of pronghorn antelope from Craig, Colorado for vesicular stomatitis virus antibodies by the plaque reduction neutralization test.

<table>
<thead>
<tr>
<th>Serotype</th>
<th>Number positive (% of tested)</th>
<th>Number (%) positive to only one serotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSV New Jersey</td>
<td>83/139 (60%)</td>
<td>63/139 (45%)</td>
</tr>
<tr>
<td>VSV Indiana</td>
<td>20/139 (14%)</td>
<td>2/139 (1%)</td>
</tr>
</tbody>
</table>

Table 2. Complement fixation test results for vesicular stomatitis virus New Jersey serotype in experimentally inoculated pronghorn does.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Day Postinoculation</th>
<th>0</th>
<th>3</th>
<th>5</th>
<th>8</th>
<th>10</th>
<th>15</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearling</td>
<td>AC&lt;sup&gt;a&lt;/sup&gt;</td>
<td>AC</td>
<td>AC</td>
<td>AC</td>
<td>AC</td>
<td>AC</td>
<td>AC</td>
<td></td>
</tr>
<tr>
<td>Adult doe</td>
<td>AC</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>--</td>
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</tr>
</tbody>
</table>

<sup>a</sup>Anticomplementary
<sup>b</sup>Nonspecific reaction

![Graph showing serum neutralization reciprocal titer over time](image-url)
AFRICAN SWINE FEVER—AN UPDATE ON ERADICATION EFFORTS AND WILD PIGS IN HAITI

Saul T. Wilson, D.V.M., Director
National Program Planning Staffs
Veterinary Services, APHIS, USDA

After the introduction of African Swine Fever (ASF) into this hemisphere in 1978, its spread from the Dominican Republic to Haiti and Cuba led many people to believe that the disease had become so widespread and had gained such a momentum that we would be unable to prevent introduction into the United States. Even though it appeared that the Dominican Republic had successfully eradicated the disease by eliminating their domestic swine population, the situation was not very optimistic because Dominican agricultural officials stated that they would be unable to prevent reintroduction of the disease when the pigs were replaced in those Dominican Provinces that share a common border with Haiti.

There was ample evidence to indicate that by 1981 a permanent foci for the disease had been established in Haiti. By that time, a serologic survey had been initiated by wildlife biologists of The University of Georgia in cooperation with Haitian technicians at the request of Dr. Frank Mulhern, Director of Animal Health for the Inter-American Institute for Cooperation in Agriculture (IICA). It was found that ASF had spread to all parts of the country (Fig. 1). Subsequent work revealed that the soft tick, *Ornithodorus puertoricensis* also was present in Haiti.

Following the successful elimination of the domestic swine population in the Dominican Republic, an ASF eradication program was initiated in Haiti under the auspices of IICA with Canada, Mexico, and the United States providing the resources and technical assistance. As in the Dominican Republic, the Haitian program called for the complete elimination of their domestic swine population. The depopulation was completed in June, 1983, and sentinel testing is scheduled for completion in December, 1983, providing there are no ASF outbreaks among the sentinel pigs.

A search operation for illegally hidden pigs, missing pigs, and wild pigs began in May, 1983, concurrent with the completion of depopulation. This activity disclosed two wild pigs in the Gonaives region in August that were serologically positive for ASF. Previous to that time, 11 feral pigs had been found in this area, all of which were negative. Discovery of sero-positive wild swine was cause for considerable concern for program officials and all persons who had been working on ASF in this hemisphere. This was the first time ASF had been found in any wild pig population in either Haiti or the Dominican Republic.

An intensive effort was immediately launched to determine how many more pigs were in the Gonaives area and to determine if they were carrying ASF virus. Permission was obtained from the Haitian government for the use of shotguns and trained dogs in an effort to capture some of the wild pigs for testing. The pig hunting has been carried out under
supervision of wildlife biologists from the Southeastern Cooperative Wildlife Disease Study, The University of Georgia. Wildlife biologists, APHIS veterinarians, and Haitian technicians have now been camping out in the area for five weeks in an effort to determine the population density and obtain samples. Six additional pigs have been captured during this period. Samples have been submitted to the laboratory from these hogs, and to date, two were negative and four are pending.

At this point in time it would be premature to say whether the disease has become established in the wild pigs in Haiti. The results of five weeks of intensive hunting and trapping efforts indicate that the wild pig populations in Haiti are very sparse and geographically limited. In six months time, only 44 wild swine have been documented throughout the entire Republic of Haiti, and of the animals tested, only 2 have been positive. We have no evidence to date that ASF has become established in soft ticks in either Haiti or the Dominican Republic. Studies in this regard are in progress and will be continued as appropriate during the repopulation effort.
REPORT OF THE
COMMITTEE ON WILDLIFE DISEASES

Chairman: E. Tom Thorne, Wyoming
Vice Chairman: Victor F. Nettles, Georgia

W. D. Bolton, VT; W. W. Buisch, MD; D. R. Cassidy, IA; A. H. Dardiri, NY; G. A. Erickson, IA; M. A. Essey, CA; J. B. Finley, Jr., TX; D. J. Gilhooley, HI; J. H. Gray, TX, F. A. Hayes, GA; D. A. Jessup, CA; D. C. Johnson, GA; W. E. Ketter, MD; R. J. Lee, VA; H. A. McDaniel, MD; E. V. Morse, IN; L. M. Siegfried, WI; J. S. Smith, NV; C. D. Stumpff, KS; A. B. Thiermann, IA; G. S. Trevino, TX; W. G. Winkler, GA.

The Committee on Wildlife Diseases convened at 1:30 p.m., October 19, 1983. Twelve committee members and 15 visitors were present. The first order of business was to review the Committee Report of 1982 and consider the status of each item previously recommended for further consideration. Items with apparent need for carry-over from Old and New Business of the 1982 Report herein are considered Old Business. Summary statements with a synopsis of action taken to date are cited as follows.

OLD BUSINESS


Drs. J. S. Smith and W. W. Buisch reviewed the history of the Memorandum and its progress in the past year. Since formation of the U.S. Animal Health Association's (USAHA) Committee on Wild and Marine Life Diseases in October, 1974 (which became the Committee on Wildlife Diseases in October, 1979), the importance of greater understanding between wildlife interests and all state and federal agricultural agencies has been emphasized. On November 11, 1976, the Committee recommended the development of a broad Memorandum of Understanding between the Animal and Plant Health Inspection Service (APHIS), USDA, and state and federal wildlife agencies in regard to mutual goals in disease prevention and control.

On September 20, 1978, a Memorandum of Understanding between APHIS, USDA, and the Fish and Wildlife Service (FWS) of the U.S. Department of the Interior was finalized and signed. This document clearly defined the jurisdiction of authority and responsibilities of both federal agencies in the event of future animal disease emergencies. Wildlife interests, represented through the International Association of Fish and Wildlife Agencies (IAFWA), had an active role in developing this memorandum.

In 1978, it was recognized by the Committee that the APHIS-FWS Memorandum of Understanding was only concerned with migratory and endangered species of wildlife in the United States. Most resident species of wildlife in the United States were not included in that they are under State authority. Therefore, APHIS was encouraged by the Com-
mittee to develop a similar agreement with individual state wildlife agencies. In 1980, the wordage for such a document was approved by the IAFWA, and by 1982, APHIS reported 22 states had completed Memorandums of Understanding. As of October 6, 1983, APHIS was pleased to report that all 50 states have finalized and signed these Memorandums of Understanding so vital to the prevention and/or eradication of exotic or indigenous diseases in resident livestock and/or poultry and wildlife populations.

RECOMMENDED ACTION: That APHIS, USDA, and this nation's state fish and wildlife agencies be commended on finalization of this first step toward greater mutual effort in combating animal diseases.

2. Compensation for Relocation of Wildlife in the Event of Depopulation as an Essential Measure for Preventing Spread of a Dangerous Contagious Disease.

Drs. J. S. Smith and W. W. Buisch reviewed the history and recent investigations regarding the question of relocation costs of wildlife following depopulation due to foreign animal disease eradication efforts.

On September 13, 1974, the 64th Convention of the International Association of Fish and Wildlife Agencies (IAFWA) urged the Secretary of Agriculture to develop a program to provide funding to state wildlife agencies for relocation costs associated with replacement of wildlife that may have to be depopulated in order to prevent establishment of a major foreign animal disease in the United States. A resolution originating from the Wild and Marine Life Diseases Committee was approved by the USAHA in November, 1975, which agreed that the Secretary of Agriculture should develop this wildlife relocation cost compensation mechanism. Consequently, the USDA reviewed the legality of compensating state wildlife agencies for costs incurred in restocking wildlife populations under the Act of May 29, 1884, as amended. The interpretation at that time was that the USDA did not have the authority for payment for such claims as proposed.

In 1978, the Wild and Marine Life Diseases Committee indicated that under certain circumstances where foreign animal diseases may involve significant segments of the wildlife resources of one or more states, it may be essential to depopulate high numbers of big game animals in order for control or eradication to be achieved. They emphasized that with no provisions to cover costs for subsequent restocking programs, an unrealistic situation existed that would precipitate severe clashes of interests relating to future animal disease eradication efforts. It was noted that today public sympathies associated with wildlife conservation often match or exceed those for agriculture. Since 1975, reimbursement for relocation of wildlife during an emergency disease outbreak has repeatedly been on the Wildlife Diseases Committee's agenda.
In 1983, USDA's Office of the General Counsel was again asked for their opinion of the legal authority for relocation costs associated with wildlife depopulation activities during an emergency. Both the Act of May 29, 1884, as amended, and the Act of July 2, 1962, were reviewed for provisions in this regard. Again it was concluded that the Department currently does not have the authority to give financial support to state fish and wildlife agencies for relocation of game animals following depopulations during an emergency disease eradication program.

RECOMMENDED ACTION: That the USAHA stand firm on its resolution of November, 1975, that urged the Secretary of Agriculture to develop a program to provide funding to state fish and wildlife agencies for replacing wildlife that would be depopulated during national disease emergencies. Because it is apparent that congressional action will be necessary, it is further recommended that USAHA work cooperatively with the IAFWA toward development and passage of an appropriate legislative package.


Dr. Victor F. Nettles of the Southeastern Cooperative Wildlife Disease Study (SCWDS) reported that following last year's USAHA resolution recommending that the USDA train wildlife veterinarians in foreign animal diseases, spaces were made available in the most recent foreign animal disease diagnostician course. A wildlife veterinarian from the California Department of Fish and Game attended sessions at Ames, Iowa, and the Plum Island Animal Disease Center, New York. A second wildlife veterinarian with the FWS, USDI, completed the Ames, Iowa, portion and will complete the Plum Island portion in May, 1984.

RECOMMENDED ACTION: The Committee commends APHIS, USDA, for including these persons in their foreign animal disease training programs and urges that this policy be continued to the extent that ample wildlife veterinarians will be available to provide each Regional Emergency Animal Disease Eradication Organization with a wildlife veterinarian/foreign animal disease diagnostician to serve as wildlife officer in time of need.

4. Tuberculosis in Bison Transmitted from Captive Elk.

Last year a report was given to this Committee concerning an outbreak of bovine tuberculosis in captive elk herds in North and South Dakota. An update on this episode was provided by Dr. C. D. Stumpff.

All three infected elk herds have been destroyed and premises have been cleaned and disinfected. One of the owners has a buffalo herd that had some contact with infected elk, but no reactors were disclosed by test a year ago. However, when the herd was re-tested this year, one animal reacted to the caudal fold test. A comparative cervical test was made, and the animal was classified as a reactor. On postmortem, thoracic lesions were observed and M. bovis was subsequently isolated. The herd was placed under quarantine by the State of South Dakota.
Herd testing currently is proceeding as outlined for bovine tuberculosis herds not depopulated. As of this date no further reactors have been disclosed. Animals are being re-tested by the caudal fold method partially because of handling problems associated with buffalo. Legal proceedings are continuing as to compensation and liability for introduction of infection. The original source of the infection has not been determined.

**RECOMMENDED ACTION:** Veterinary Services and state agencies responsible for livestock, fish and wildlife, and public health should be commended for persistence in controlling this outbreak of bovine tuberculosis in captive elk and bison. It was also recommended that the various State Veterinarians be appraised of the jurisdictional problems demonstrated by this incident.

5. **Surveillance for Duck Plague Virus in Wild Waterfowl.**

Dr. Milton Friend, Director of the National Wildlife Health Laboratory, FWS, USDI, reported that the FWS has completed a two-year survey of wild ducks for duck plague. Over 5,000 birds were sampled, and surveillance covered all four major flyways. Although sampling was more extensive in areas of previous epizootics, duck plague virus was not found in any birds. Dr. Friend suggested these data indicated duck plague virus was below enzootic levels in wild waterfowl.

**RECOMMENDED ACTION:** That the FWS be commended for their efforts to advance an understanding of the epizootiology of duck plague.

6. **Mycoplasmosis in Wild Turkeys, Summary of Recent Research.**

Tonie E. Rocke, University of Wisconsin, described experiments being conducted to determine the effects of *Mycoplasma* infections in wild turkeys. Game farm turkeys were used in initial experiments as a model for further studies in wild birds. Adult hens and toms were infected with *Mycoplasma gallisepticum* via the respiratory route at the beginning of the breeding season and allowed to mate normally. Controls received sterile broth only. Eggs were collected daily and incubated until hatched. Egg production of infected hens (5.2 eggs/hen) was five times lower than the uninfected control hens (25.9 eggs/hen). Hatchability of eggs from infected hens (34%) was also significantly reduced compared to controls (53%). Fertility was unaffected by treatment; 88% of all eggs laid were fertile.

Ms. Rocke said that it was probable these same effects will be observed in free-ranging wild turkeys, but this remains to be tested. The occurrence of *Mycoplasma* spp. infections in wild turkeys is unknown. Serologic surveys and isolation attempts from live trapped and hunter killed wild turkeys currently are being conducted. The information supplied by these experimental and field studies could provide a basis for decisions regarding the future management of wild turkeys.

**RECOMMENDED ACTION:** Wildlife agencies should be encouraged to conduct *Mycoplasma* testing on wild turkeys captured in relocation
programs, and members of the Wildlife Diseases Committee should help state agricultural and wildlife officials work together to assess this problem by methods that will not impede the progress of wild turkey restoration.

NEW BUSINESS

1. Heartwater Disease in White-tailed Deer.

Dr. John McVicar of the Plum Island Animal Disease Center (PIADC), ARS, USDA, reported to the Committee on the results of their recent experimental heartwater infections in white-tailed deer. Infection resulted in a two-week disease course with clinical signs typical of fatal heartwater. Passage of infected blood from goats to deer and deer to deer was lethal to the recipient animals.

Dr. McVicar expressed concern that white-tailed deer could be an important host for heartwater infection if the disease was introduced into the United States. In addition to the fact that this abundant big game animal is susceptible, white-tailed deer also serve as hosts for seven species of *Amblyomma* ticks including a capable vector species, *A. maculatum*.

**RECOMMENDED ACTION:** The Wildlife Diseases Committee applauds the action taken by PIADC to illucidate the potential threat that heartwater disease poses to native wild ruminants. The Committee expressed alarm to the fact that white-tailed deer are susceptible to heartwater and urges further investigations on heartwater in wild ruminants, especially in regard to the vector capability of native *Amblyomma* ticks.

2. Vesicular Stomatitis on Ossabaw Island, Georgia.

Dr. G. A. Erickson of the National Veterinary Services Laboratories (NVSL), APHIS, USDA, and Dr. V. F. Nettles of the Southeastern Cooperative Wildlife Disease Study (SCWDS) reported on vesicular stomatitis (VS) investigations associated with VS-enzootic Ossabaw Island, Georgia.

Vesicular stomatitis has been diagnosed serologically in wild swine, cattle, and white-tailed deer on many occasions (1965, 1969, 1970, 1978-1983) from Ossabaw Island. During the past 3 years, NVSL and SCWDS have conducted extensive serologic surveys on the Island's wild mammals and birds, and New Jersey strain VS virus titers have been found in swine, cattle, horses, burros, white-tailed deer, and raccoons.

A high prevalence of seropositive feral swine led to the use of juvenile swine as sentinels through a capture-mark-release system in 1982 and 1983. In these animals, seroconversions appeared in late May to early June and continued into the summer. Vesicles were not seen in 1982; however, two clinically infected wild swine were found in July, 1983. Samples from these two animals yielded New Jersey strain VS virus at PIADC and NVSL. Numerous negative observations of cattle, horses,
burros, white-tailed deer, and additional wild swine were made concurrent to the appearance of vesicles in the two swine.

Dr. Erickson reported that he had conducted swine inoculation trials with the 1983 Ossabaw Island isolate and a New Jersey strain VS virus isolate from the 1983 Western United States outbreak in cattle and horses. Swine appeared to be far less susceptible to clinical infection with the cattle-derived Western VS virus than the Ossabaw VS virus. Furthermore, there was an apparent dose-dependent relationship for producing clinical lesions with the Ossabaw VS virus isolate in swine.

RECOMMENDED ACTION: The Committee was encouraged by the insight these studies have provided on the epizootiology of VS virus in an endemic area. The Committee urges the continuation of VS investigation on Ossawab Island through a cooperative effort between APHIS and SCWDS to help define the reservoir and mode of transmission of enzootic VS.


Dr. Saul T. Wilson, APHIS, USDA, reviewed the African Swine Fever (ASF) eradication programs on the Dominican Republic and Haiti. Dr. Wilson reported that the Dominican Republic is repopulating swine and Haiti is undergoing sentinelization.

Of interest to the Committee was the discovery of isolated groups of free-living swine in two areas in Haiti. Extensive efforts to obtain infected animals from these populations have yielded only two positive pigs; however, these positives represent the first ASF-infected wild swine disclosed on either the Dominican Republic or Haiti. Dr. Wilson indicated that it was too early to determine if ASF had become established in wild swine on Haiti; however, his assessment was that the feral swine were not numerous and, therefore, hopefully would not be an obstacle to the eradication program.

RECOMMENDED ACTION: That the agencies involved in eradication of ASF on Haiti be encouraged to fully investigate the status of wild swine on Haiti in regard to establishment of the disease. It is foreseen that the findings of this investigation will be applicable to other ASF eradication programs where wild swine are present.

4. Isolation of Bluetongue Type 2 Virus in Florida.

Dr. T. L. Barber reported that the Arthropod-borne Animal Diseases Research Laboratory, ARS, USDA, isolated a bluetongue virus from cattle in Florida that had never been found in the Western Hemisphere. Genetic material from 12 of 17 virus isolates was indistinguishable from the 23-year-old African prototype for bluetongue serotype 2. Four subsequent viral isolates had differences that indicated the virus has already undergone reassortment in the U.S. The genetic material from all serotype 2 isolates was markedly different from that of the four serotypes (10, 11, 13, 17) known to exist in the U.S. The close similarity of the serotype 2 isolates to the African prototype strain and the re-
markable differences from the domestic serotypes strongly suggest that the virus was introduced into the U.S. rather than evolving from the four enzootic serotypes. Dr. Barber suggested the most logical means of introduction would be latently infected ruminant animals such as cattle from the Caribbean Area, South America, or Mexico or from exotic animals imported from Africa. Dr. Barber indicated that the discovery of bluetongue virus serotype 2 could pose a new threat to sheep, cattle, and wildlife in the U.S.

**RECOMMENDED ACTION:** The Committee expressed concern about the potential threat to native wild ruminants posed by the introduction of new bluetongue serotype. Furthermore, the unexplained appearance of this new serotype exemplifies the need for stronger control and assurance of a disease-free status of wild and domestic ruminants introduced into the continental United States.

5. **Distribution Maps of Cloven-hooved Wildlife.**

Dr. Victor F. Nettles displayed color-coded population density maps for white-tailed deer, feral swine, and collared peccary in the United States. The maps were a part of a nationwide inventory of foot and mouth disease-and rinderpest-susceptible wild animals being conducted through a Cooperative Agreement between Veterinary Services, APHIS, USDA, and the SCWDS. Data for the maps were obtained from state and federal wildlife management agencies, and maps for all species will soon be ready for distribution. Dr. Nettles indicated that these maps have been well received by wildlife agencies for use in demonstrating their big game resources.

**RECOMMENDED ACTION:** The Committee commends APHIS for development of these inventory maps which will greatly expedite the assessment of potential wildlife involvement in the event of a foreign animal disease introduction.

6. **Proposal for a Rare and Endangered Ruminant Breeding Facility on St. Catherines Island, Georgia.**

Dr. David Herrick, Import-Export Programs, APHIS, USDA, reported to the Committee on an application to APHIS for establishment of a permanent post-entry quarantine facility on St. Catherines Island, Georgia. At such establishments, wild animals may be imported to the U.S. regardless of disease status of the country of origin. Although the imported animals must be confined permanently in the post-entry quarantine facility, offspring from these animals may go anywhere in the United States. Investigations to date have revealed that present confinement and isolation standards for a post-entry quarantine facility on St. Catherines Island do not meet current APHIS guidelines.

Dr. Herrick explained that the proposal has generated considerable interest among USAHA members, and there was a consensus to concentrate discussions on the matter in the USAHA's Epizootic Attack Committee. However, Wildlife Diseases Committee members and guests expressed concern and commented on the following related
topics: (1) inconsistencies regarding testing for exotic diseases in imported domestic and exotic animals; (2) possibilities of extending APHIS’s authority for more stringent disease testing; (3) free-ranging wildlife and potential insect vector populations in the Georgia coastal area; (4) unregulated dispersal of progeny of exotic ruminants from permanent post-entry quarantine zoos to private game ranches; and (5) the importance of said animals in the epizootiology of such diseases as malignant catarrhal fever and bluetongue.

**RECOMMENDED ACTION:** That USAHA express concern about the potential for foreign animal disease introduction into the United States via exotic ruminants and support all efforts to assure native wild and domestic animal populations receive the protection these important national resources deserve.

7. **Leptospirosis and Wildlife, Summary of Recent Developments.**

Dr. Alex B. Thiermann reported to the Committee that USDA has established a National Reference Center for Leptospirosis in Ames, Iowa. The Center will function as two separate sections, i.e., a Diagnostic Section under APHIS, NVSL, represented by the Chief of the Diagnostic Bacteriology Laboratory, and a Research Section under ARS, NADC, represented by the Leader of the Leptospirosis Research Laboratory. The former will be responsible for providing additional serologic capabilities, developing competency to type and characterize leptospiral serovars, providing training and reagents, and providing epidemiological consultation for the control of leptospirosis in domestic animals. The latter will be responsible for developing improved techniques for the isolation and characterization of unusual leptospiral serovars, expanding research efforts to determine the pathogenicity of unrecognized leptospires, identifying and characterizing immunogenic components of leptospiral serovars, and developing improved diagnostic techniques.

The Research Section at NADC also has conducted and will continue to conduct work on new isolation procedures; pathogenicity on laboratory animals and pregnant cattle; endonuclease analysis of leptospiral DNA; cloning of DNA for studies with leptospiral surface proteins, and cooperative research in the epidemiology of leptospirosis in livestock and wildlife.

In the area of wildlife diseases, the Research Section has been involved in the distribution of reagents and procedures, assistance in serologic diagnosis and isolation attempts, and typing of isolates. A current cooperative research project involves leptospirosis in pronghorn antelope and its potential relationship to livestock.

**RECOMMENDED ACTION:** That USAHA commend NVSL and NADC for cooperatively establishing the much needed National Reference Center for Leptospirosis and that further research regarding the relationships of livestock, wildlife, and leptospirosis be encouraged.

Dr. Mitchell A. Essey reported to the Committee on bovine tuberculosis surveillance in wildlife on Molokai Island. In 1978, an endemic foci of tuberculosis was identified in a cattle herd on the East end of Molokai Island. Because wild deer and swine were suspect as reservoirs of tuberculosis for cattle, 100 axis deer and 61 wild swine were killed and examined in 1980 through a Cooperative Agreement between APHIS and SCWDS. The axis deer were found free of infection; however, a significant prevalence of infection was identified in feral swine. Conclusions drawn from that survey were that feral swine were a possible source for infection.

After the initial survey, the cattle were depopulated and the area was opened to extensive sporthunting to reduce the feral swine population. Cattle were reintroduced onto the premises in 1982, and a second wild swine survey was made in 1983. Results of the second survey revealed that the prevalence of infection on the previously surveyed area was significantly lower at the 90% confidence level. Samples from a large number of wild swine taken from adjacent areas on the island were negative. The conclusion drawn from this work was that the infection in wild swine was localized but that wild swine could maintain infection in the absence of infected cattle.

RECOMMENDED ACTION: The Committee applauds APHIS for the thoroughness of this epidemiologic investigation and encourages continued localized population control of the swine with simultaneous monitoring for tuberculosis.
88th ANNUAL MEETING
October 21-26, 1984
HYATT REGENCY HOTEL
Fort Worth, Texas

89th ANNUAL MEETING
October 27-November 1, 1985
THE MARC PLAZA HOTEL
Milwaukee, Wisconsin

90th ANNUAL MEETING
October 19-24, 1986
EXECUTIVE WEST HOTEL
Louisville, Kentucky