PROCEEDINGS
EIGHTIETH
ANNUAL MEETING
of the
UNITED STATES ANIMAL HEALTH ASSOCIATION
AMERICANA HOTEL
Miami Beach, Florida
November 7, 8, 9, 10, 11, 12, 1976
PROCEEDINGS

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ANNUAL MEETING

of the
UNITED STATES
ANIMAL HEALTH
ASSOCIATION

AMERICANA HOTEL
November 7, 8, 9, 10, 11, 12, 1976
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<td>Fort Worth, TX</td>
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<td>Mississippi State, MS</td>
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<tr>
<td>Hardin E. Gouge</td>
<td>St. Joseph, MO</td>
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<tr>
<td>James C. Hanson</td>
<td>St. Paul, MN</td>
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<td>William Knapp</td>
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<td>G. Dean Lindsey</td>
<td>Carmel, IN</td>
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<td>Joseph S. Hayden</td>
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<td>Fred Oehme</td>
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<td>Sam F. Scheidy</td>
<td>Bryn Mawr, PA</td>
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<td>Norman Tufts</td>
<td>Boston, MA</td>
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<tr>
<td>Jerry Brunton</td>
<td>Washington, DC</td>
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<tr>
<td>Gail B. Smith</td>
<td>Somerville, NJ</td>
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### Committee on Professional Oversight—1977

Dr. J. L. O’Harra, Chairman, Reno, NV  
Dr. Douglas R. Stauffer, Co-Chairman, Pickerington, OH  

<table>
<thead>
<tr>
<th>Name</th>
<th>City, State</th>
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<tr>
<td>J. F. Andrews</td>
<td>Atlanta, GA</td>
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<tr>
<td>L. E. Bartelt</td>
<td>Sacramento, CA</td>
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<tr>
<td>J. R. Bishop</td>
<td>Tipton, IN</td>
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<tr>
<td>D. E. Flagg</td>
<td>Bismark, ND</td>
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<tr>
<td>H. E. Goldstein</td>
<td>Reynoldsburg, OH</td>
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<tr>
<td>G. C. Halver</td>
<td>Helena, MT</td>
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<tr>
<td>J. B. Healy</td>
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<tr>
<td>J. M. Hejl</td>
<td>Washington, DC</td>
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<tr>
<td>J. L. Hourigan</td>
<td>Hyattsville, MD</td>
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<tr>
<td>A. E. Janawicz</td>
<td>Montpelier, VT</td>
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<tr>
<td>T. A. Ladson</td>
<td>Annapolis, MD</td>
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<tr>
<td>Robert Laramore</td>
<td>Gillette, WY</td>
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<tr>
<td>E. A. Schilf</td>
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<tr>
<td>H. Q. Sibley</td>
<td>Austin, TX</td>
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<td>O. H. Timm</td>
<td>Dixon, CA</td>
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<tr>
<td>W. C. Tobin</td>
<td>Denver, CO</td>
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<tr>
<td>C. D. VanHouweling</td>
<td>Washington, DC</td>
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<tr>
<td>Paul Zillman</td>
<td>Hinsdale, IL</td>
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### Committee on Public Health—1977

Dr. Richard L. Parker, Chairman, Columbia, SC  
Dr. R. H. Singer, Co-Chairman, Winchester, KY  

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<th>Name</th>
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<tr>
<td>R. H. Singer</td>
<td>Winchester, KY</td>
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<tr>
<td>J. E. Spaulding</td>
<td>Beltsville, MD</td>
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<tr>
<td>E. E. Wedman</td>
<td>Corvallis, OR</td>
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<tr>
<td>J. F. Stara</td>
<td>Cincinnati, OH</td>
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<tr>
<td>L. P. Thomas</td>
<td>Charleston, WV</td>
</tr>
<tr>
<td>Charlie Jungmichel</td>
<td>Austin, TX</td>
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<tr>
<td>H. G. Geyer</td>
<td>Washington, DC</td>
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<tr>
<td>J. H. Steele</td>
<td>Houston, TX</td>
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<tr>
<td>M. R. Levy</td>
<td>Philadelphia, PA</td>
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<tr>
<td>William Hubbert</td>
<td>Baton Rouge, LA</td>
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<tr>
<td>T. B. Snodgrass</td>
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<td>L. W. Schurrenberger</td>
<td>Beltsville, MD</td>
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<td>J. L. Wilbur</td>
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<td>Forrest Ireland</td>
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<td>H. M. Trabash</td>
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<td>L. W. Hinchman</td>
<td>Indianapolis, IN</td>
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<td>E. D. Baker</td>
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<td>Irvin L. Peterson</td>
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<tr>
<td>Jack C. Leighty</td>
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<tr>
<td>Harry Christian</td>
<td>Twin Brooks, SD</td>
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<tr>
<td>James Williams</td>
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<td>James E. Pearson</td>
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<tr>
<td>Rowland McIlwraith</td>
<td>Holdrege, NE</td>
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<tr>
<td>C. E. Knolle</td>
<td>Sandia, TX</td>
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<td>John C. Prucha</td>
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### Advisory Committee

<table>
<thead>
<tr>
<th>Name</th>
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<tr>
<td>D. D. Juranek</td>
<td>Atlanta, GA</td>
</tr>
<tr>
<td>W. C. Patterson</td>
<td>Athens, GA</td>
</tr>
<tr>
<td>J. F. Stara</td>
<td>Cincinnati, OH</td>
</tr>
<tr>
<td>W. E. Jennings</td>
<td>Santa Rose Beach, FL</td>
</tr>
<tr>
<td>Leon Russell</td>
<td>College Station, TX</td>
</tr>
<tr>
<td>A. Bill Childers</td>
<td>College Station, TX</td>
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</table>
Committee on Rabies—1977
Dr. R. Keith Sikes, Chairman, Atlanta, GA
Dr. E. A. Carbery, Co-Chairman, Ames, IA

John Brown, Washington, DC                        Bruce Kaplan, Louisville, KY
L. N. Butler, Phoenix, AZ                           J. F. Frank, Quebec, Canada
Victor Cabasso, Berkeley, CA                        T. D. Njako, Charles, WV
James Glosser, Helena, MT                           A. L. Strating, Ames, IA
Marvin Goff, Ames, IA                               E. H. Willers, Honolulu, HI
W. G. Winkler, Atlanta, GA

Committee on Salmonella—1977
Dr. Erskine V. Morse, Chairman, West Lafayette, IN
Dr. Harry G. Geyer, Co-Chairman, Washington, DC

Harry E. Goldstein, Sec., Reynoldsburg, OH
E. T. Mallison, Mechanicsburg, PA
G. H. Snoeyenbos, Amherst, MA
Conwell W. Johnson, Des Plaines, IL
Raymond Schar, Beltsville, MD
Frank A. Hayes, Athens, GA
Morris Cover, St. Louis, MO
Donald C. Blenden, Columbia, MO
Billie O. Blackburn, Washington, DC
William Stringer, Columbia, MO
Max Crandall, San Juan Station, Puerto Rico
L. C. Grumbles, College Station, TX
Louis N. Locke, Madison, WI
Don H. Spangler, Lacey, WA
William B. Bixler, Rockville, MD
Ralph Johnston, Washington, DC
Rube Harrington, Jr., Ames, IA
Ben S. Pomeroy, St. Paul, MN
Robert Hogue, West Lafayette, IN
Morris E. Potter, Atlanta, GA
J. E. Williams, Athens, GA
Stanley L. Diesch, St. Paul, MN

Committee on Sheep and Goats—1977
Dr. F. James Schoenfeld, Chairman, Salt Lake City, UT
Dr. M. E. Macheak, Co-Chairman, Ames, IA

Clair E. Terrill, Beltsville, MD
Percey R. Turner, Water Valley, TX
T. Lynwood Barber, Denver, CO
Richard F. Hall, Caldwell, ID
R. E. Simmons, Boise, ID
Thomas B. Snodgrass, Dallas, TX
A. S. Klingsporn, Bowie, MD
H. A. Hancock, Laramie, WY
J. S. Hourrigan, Hyattsville, MD
Guy E. Reynolds, Corvallis, OR
Howard W. Whitford, College Station, TX
John Neimi, Buffalo, SD
Olin H. Timm, Dixon, CA

J. E. Pearson, Ames, IA
Committee on State-Federal Relations—1977
Dr. L. E. Bartelt, Chairman, Sacramento, CA

A. E. Janawicz, Montpelier, VT
T. F. Zweigart, Raleigh, NC
H. E. Goldstein, Columbus, OH
B. W. Hawkins, Ontario, OR

W. L. Bendix, Richmond, VA
J. C. Shook, Frederick, MD
D. H. Spangler, Olympia, WA
T. A. Ladson, Annapolis, MD

J. L. O’Harra, Reno, NV

Committee on Transmissible Diseases of Poultry—1977
Dr. R. A. Bankowski, Chairman, Davis, CA
Dr. W. Butterfield, Co-Chairman, Plum Island, NY

Everett S. Bryant, Storrs, CT
Francis G. Buzzell, Augusta, ME
H. E. Goldstein, Columbus, OH
L. C. Grumbles, College Station, TX
Porter Halbert, Austin, TX
J. E. Hanley, Dade City, FL
R. L. Hogue, Lafayette, IN
Lloyd Jones, Hopkinsville, KY
Daryl King, Hyattsville, MD
Thomas L. Landers, Hot Springs, AR

R. McCapes, Davis, CA
W. E. Merritt, Siloam Springs, AR
Harold E. Nadler, Albany, NY
W. C. Patterson, Jr., Athens, GA
Irvin L. Peterson, Beltsville, MD
B. S. Pomeroy, St. Paul, MN
James B. Roberts, Muldrow, OK
Terrell B. Ryan, Cary, NC
John A. Smiley, Augusta, ME
H. Wesley Towers, Dover, DE

Committee on Transmissible Diseases of Swine—1977
Dr. E. A. Butler, Chairman, Des Moines, IA
Dr. T. F. Zweigart, Co-Chairman, Raleigh, NC

Neal Black, St. Paul, MN
E. H. Bohl, Wooster, OH
Carl E. Boyd, Elgin, SC
Don Brothers, Paducah, TX
James E. Fox, Ashland, OH
R. W. Ger ding, Hyattsville, MD
Robert D. Glock, Ames, IA

Lowell Hinchman, Indianapolis, IN
John P. Kluge, Ames, IA
Donald L. Kruger, Olympia, WA
N. W. Kruse, Lincoln, NE
Don L. Larson, Brookings, SD
Tom Powell, Athens, GA
Miodrag Ristic, Urbana, IL

W. C. Stewart, Ames, IA
M. W. Vorhies, Brookings, SD
John W. Walker, Hyattsville, MD
F. D. Wertman, Des Moines, IA

Donald P. Gustafson, West Lafayette, IN
E. O. Hael ter man, West Lafayette, IN
Robert E. Hall, Madison, WI
Howard Hill, Ames, IA
Committee on Tuberculosis and Johne's Disease—1977

Dr. P. L. Smith, Chairman, Sacramento, CA
Dr. A. R. McLaughlin, Co-Chairman, Madison, WI

R. W. Bennett, Hyattsville, MD
Neal Black, St. Paul, MN
Carl E. Boyd, Columbia, SC
Albert M. Carey, Beltsville, MD
John Dick, Harrisburg, PA
Charles S. Duncan, Albany, NY
J. G. Flint, St. Paul, MN
G. H. Frye, Hyattsville, MD
D. W. Johnson, Roseville, MN
A. F. Kaufmann, Atlanta, GA
Victor LaBranche, Boston, MA
A. B. Larsen, Ames, IA

Joseph L. McMillan, Wheatland, CA
H. E. Nadler, Albany, NY
A. P. Schneider, Boise, ID
G. R. Snyder, Washington, DC
G. W. Spangler, Des Moines, IA
R. J. Stadler, Hartford, CT
M. S. Silberman, Reynolds, GA
Charles Thoen, Ames, IA
K. M. Weinland, Lafayette, IN
Lindsey Horn, Chicago, IL
Paul L. Spencer, Springfield, IL
J. B. Young, Austin, TX

Committee on Wild and Marine Life Diseases—1977

Dr. Frank A. Hayes, Chairman, Athens, GA

T. Lynwood Barber, Denver, CO
Don E. Cooperrider, Kissimmee, FL
Ahmed H. Dardiri, Greenport, Long Island, NY
Joe B. Finley, Jr., Encinal, TX
Harry G. Geyer, Washington, DC
Lynn A. Griner, San Diego, CA
Andrew H. Hulsey, Little Rock, AR

Stewart H. Madin, Berkeley, CA
Benjamin S. Pomeroy, St. Paul, MN
Robert E. Putz, Washington, DC
James S. Smith, Hyattsville, MD
Gilberto S. Trevino, College Station, TX
Lonnie L. Williamson, Washington, DC
William G. Winkler, Atlanta, GA
Erskin V. Morse, West Lafayette, IN

Committee on Zoological Animals—1977

Dr. R. M. S. Temple, Chairman, Bristolville, OH
Dr. Keith C. Sherman, Co-Chairman, Hyattsville, MD

Dale Swindaman, Hyattsville, MD
Gordon Hubbell, Miami, FL
George Pearson, Washington, DC
Al Decoteau, Waltham, MA
A. R. McLaughlin, Madison, WI

George Becker, Orlando, FL
Don Farst, Brownsville, TX
John Banks, Lorena, TX
Ron M. Scott, Lansing, MI
Charles P. Chase, Miami, FL
<table>
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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>15. Dec 5-6, 1911</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>25. Nov. 28-30, 1921</td>
<td>Chicago, Ill.</td>
<td>*Dr. W. F. Crewe, Bismarck, N.D.</td>
<td>*Dr. Theo. A. Burnett, Columbus, Ohio</td>
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<tr>
<td>26. Dec. 6-8, 1922</td>
<td>Chicago, Ill.</td>
<td>*Dr. T. E. Munce, Harrisburg, Pa.</td>
<td>*Dr. Theo. A. Burnett, Columbus, Ohio</td>
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<td>Date</td>
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<tr>
<td>Nov. 30-Dec. 1-2, 1927</td>
<td>Chicago, Ill.</td>
<td>*Dr. L. Van Es, Lincoln, Neb.</td>
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<tr>
<td>Dec. 4-6, 1929</td>
<td>Chicago, Ill.</td>
<td>*Dr. Chas. G. Lamb, Denver, Colo.</td>
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<tr>
<td>Dec. 3-5, 1930</td>
<td>Chicago, Ill.</td>
<td>*Dr. A. E. Wight, Wash., D.C.</td>
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<tr>
<td>Nov. 30-Dec. 1-2, 1932</td>
<td>Chicago, Ill.</td>
<td>*Dr. Peter Malcolm, Des Moines, Iowa</td>
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<td>Dec. 6-8, 1933</td>
<td>Chicago, Ill.</td>
<td>*Dr. E. T. Faulder, Albany, N.Y.</td>
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<td>Dec. 5-7, 1934</td>
<td>Chicago, Ill.</td>
<td>*Dr. T. E. Robinson, Providence, R.I.</td>
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<td>Dec. 24, 1936</td>
<td>Chicago, Ill.</td>
<td>*Dr. Walter Wisnicky, Madison, Wis.</td>
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<td>Dec. 6-8, 1939</td>
<td>Chicago, Ill.</td>
<td>*Dr. J. L. Axby, Indianapolis, Ind.</td>
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<td>Dec. 4-6, 1940</td>
<td>Chicago, Ill.</td>
<td>*Dr. H. D. Port, Cheyenne, Wyo.</td>
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<td>Dec. 3-5, 1941</td>
<td>Chicago, Ill.</td>
<td>*Dr. E. A. Crossman, Boston, Mass</td>
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<td>Dec. 1-3, 1943</td>
<td>Chicago, Ill.</td>
<td>Dr. W. H. Hendricks, Salt Lake City, Utah</td>
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<td>Dec. 6-8, 1944</td>
<td>Chicago, Ill.</td>
<td>Dr. J. M. Sutton, Atlanta, Ga.</td>
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<td>Dec. 5-7, 1945</td>
<td>Chicago, Ill.</td>
<td>Dr. C. U. Duckworth, Sacramento, Calif.</td>
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<tr>
<td>Oct. 12-14, 1949</td>
<td>Columbus, Ohio</td>
<td>*Dr. T. O. Brandenburg, Bismarck, N.D.</td>
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</tr>
<tr>
<td>Nov 14-16, 1951</td>
<td>Kansas City, Kan.</td>
<td>*Mr. F. E. Mollin, Denver, Colo</td>
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<tr>
<td>Sept. 23-25, 1953</td>
<td>Atlantic City, N.J.</td>
<td>*Dr. T. Childs, Ottawa, Canada</td>
<td></td>
</tr>
<tr>
<td>Nov. 10-12, 1954</td>
<td>Omaha, Neb.</td>
<td>*Dr. T. C. Green, Charleston, W.Va.</td>
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<td>Nov. 28-30, 1956</td>
<td>Chicago, Ill.</td>
<td>Dr. A. L. Brueckner, Baltimore, Md.</td>
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</tr>
<tr>
<td>Nov. 13-15, 1957</td>
<td>St. Louis, Mo.</td>
<td>Dr. G. H. Good, Cheyenne, Wyo.</td>
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### RECORD OF PREVIOUS MEETINGS—Continued

<table>
<thead>
<tr>
<th>Date</th>
<th>Place of Meeting</th>
<th>President</th>
<th>Secretary</th>
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<tbody>
<tr>
<td>62. Nov. 4-6, 1958</td>
<td>Miami Beach, Fla.</td>
<td>Dr. John G. Milligan, Montgomery, Ala.</td>
<td>Dr. R. A. Hendershott, Trenton, N.J.</td>
</tr>
<tr>
<td>63. Dec. 15-18, 1959</td>
<td>San Francisco, Calif.</td>
<td>Mr. F. G. Buzzell, Augusta, Me.</td>
<td>Dr. R. A. Hendershott, Trenton, N.J.</td>
</tr>
<tr>
<td>65. Oct. 3-Nov. 1-3, 1961</td>
<td>Minneapolis, Minn.</td>
<td>Dr. A. P. Schneider, Boise, Idaho.</td>
<td>Dr. R. A. Hendershott, Trenton, N.J.</td>
</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>
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<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>
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<tr>
<td>80. Nov. 7-12, 1976</td>
<td>Miami Beach, Fla.</td>
<td>H. E. Goldstein, Columbus, Oh.</td>
<td>Dr. W. L. Bendix, Richmond, Va.</td>
</tr>
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</table>

*Deceased †Reprinted in 54th Annual Report ††Reprinted in the 66th Annual Report
+This was the last meeting of the Interstate Association of Livestock Sanitary Boards
INVOCATION AND MEMORIAL SERVICE
F. James Schoenfeld, DVM
Salt Lake City, UT

Our Father in Heaven, Hallowed be Thy Name. We come before Thee this night at the convening of the 80th Annual meeting of the United States Animal Health Association and the 19th Annual Conference of the American Association of Veterinary Laboratory Diagnosticians.

We thank Thee for this privilege and opportunity to meet together, to learn together, and to better prepare ourselves for the responsibilities ahead of us.

May we be mindful of the Scriptures thou has given unto us as a guide in our lives and our professions. May we assume the charge of the responsibility given to man over the animal kingdom, that we may be diligent in this charge. We are mindful of the disease problems, and we appreciate the opportunities to work with these problems. We realize also that we will be faced with greater problems in the future. May we be worthy and capable to accept these challenges, that we will have food and raiment for the peoples of this earth. We pray that we will have a greater understanding of the diseases that may inflict these animals and mankind as well.

We pray for the leadership of these organizations. May they be blessed with Leadership ability to carry on the responsibility given to them. May we fulfill our assignments as given by them.

We pray for our families who are not with us, may they be blessed and protected while we are away from them. Bless those families who are with us here at these association meetings.

We pray for our friends and colleagues who are not able to attend because of Health and other duties, may they be helped.

We pray for the Leadership of this nation, may they seek Thee in prayer for guidance, and may we support them in their responsibilities as they lead this great Nation.

Again Father, we are thankful for thy many blessings, and pray that we may so live our lives to continue to receive thy blessings.

We pray in the name of Jesus Christ,

Amen.
MEMORIAL SERVICE

Mr. President, Members of the Association, Ladies and Gentlemen.

At this time, as is our custom, we pause for a moment of silent prayer and Reverence to pay tribute to those friends and colleagues who have now completed their mortal existence and have passed on to paradise.

1. Dr. Walt Fechner of Little Rock, Arkansas, who passed away in April 1976. He was Chairman of "Food Animal and Hygiene Inspection Committee."


3. Dr. Guy W. Eberhardt, summer of 1976.

4. Dr. F. R. Lucas, summer of 1976.
REPORT OF THE SECRETARY

W. L. Bendix, DVM
Richmond, Virginia

It is a real pleasure to report to the membership that our Association had a very good year in fiscal 1976. I reported last year at Portland, that we had increased our dues paying membership by an even 100 members. Again this year, our individual membership has grown by about the same number. During 1976, we had 809 paid individual members. This is healthy growth and represents renewed interest in the work we do. In addition, we have 22 new applications for individual membership to present at this meeting.

Since our Constitution was changed to include what we call, "Allied Organization Members," 14 such groups have been elected to such membership. Our Constitution provides that these groups must have the same general aims and interests as does our Association, be non profit, and national in scope and membership. Each such group accepted is given a seat on our Executive Committee and pays the same dues as do our official members. This year, I will present for consideration to the Executive Committee, the applications of 5 additional organizations; The National Dairy Herd Improvement Association, Columbus, Ohio; The American Stockyards Association, Omaha, Nebraska; The National Milk Producers Federation, Washington, D. C.; The American Association of Swine Practitioners, Des Moines, Iowa; and, The Holstein Friesian Association of America, Brattleboro, Vermont. If each of these is accepted, it will make a total of 19 such members that represent a true cross section of America's animal agriculture in all of its aspects. The United States Animal Health Association has the opportunity, if the talent available in its diversified membership is properly used, to stand unique in its service and influence throughout the nation. We must find work for all of this talent to do. Certainly, working together, there is nothing we cannot accomplish in our chosen field.

This year, in addition to our 79th Annual Proceedings, we published and distributed an updated, "Foreign Animal Disease Handbook," 3rd Edition. Our Committee on Foreign Animal Diseases under the very able and dedicated chairmanship of General Thomas G. Murnane, V.C., U. S. Army, is to be congratulated on a job well done. Copies of this new and revised handbook may be purchased from the Association. Send your orders to our office in Richmond or place them here at the registration desk in the lobby. They are now in stock and delivery will be made promptly.

As the work of our Association increases in scope and complexity, and as the list of our Allied and Satellite group grows, finding an adequate place for each of them to meet is becoming increasingly
more difficult. This year we have, in addition to our general sessions, 11 satellite groups and 32 working committees holding separate meetings, some on consecutive days. We have had separate requests from non-allied but interested groups who will attend our meetings for meeting space of their own. We have reached and maybe passed the bursting point. I sincerely hope that each of you find the space and time provided, adequate to your needs. We have done our best for you. This meeting bids far to be the largest we have ever had. We hope you all will contribute something and gain something here this week.

The report of our very able Treasurer, Dr. John Shook, which will be presented shortly is also heartening. With a growing membership, and increasing demands for service, we face the immediate need for additional office space and additional personnel, at least part time to get the job done. Inflation is, of course, still our main enemy, but perhaps the corner of solvency has been turned.

Don’t forget to contact T. J. Grennan, if you have suggestions for revision in our Constitution and Bylaws. The first draft will probably be presented at this meeting.

We hope you all have a good week here at the Americana and in the Miami Beach area. If we can be of assistance, please don’t hesitate to contact us. The hotel staff tells us that they want your stay to be profitable and most enjoyable, and only wait your requests to be of service. Remember, next year we go to the upper middle west, Minneapolis, Minnesota, and after that to Buffalo, New York. In 1979, we return to the west. The place will be selected at this meeting.

Respectfully submitted,

W. L. Bendix, DVM
Secretary
UNITED STATES ANIMAL HEALTH ASSOCIATION
1910 BYRD AVENUE, ROOM 118
RICHMOND, VIRGINIA 23230

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS FOR
PERIOD OCTOBER 1, 1975 THROUGH SEPTEMBER 30, 1976

CASH BALANCE—OCTOBER 1, 1975:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash on Hand October 1, 1975</td>
<td>$137.46</td>
</tr>
<tr>
<td>Southern Bank and Trust Company</td>
<td></td>
</tr>
<tr>
<td>Checking Account</td>
<td>187.73</td>
</tr>
<tr>
<td>Savings Account</td>
<td>7,780.33</td>
</tr>
<tr>
<td></td>
<td><strong>$8,105.52</strong></td>
</tr>
<tr>
<td>Trevose Savings and Loan Association</td>
<td></td>
</tr>
<tr>
<td>Morrisville, Pennsylvania</td>
<td>1.00</td>
</tr>
<tr>
<td>Sandia Savings and Loan Association</td>
<td>1.00</td>
</tr>
<tr>
<td>Albuquerque, New Mexico</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>$8,107.52</strong></td>
</tr>
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INCREASED BY CASH RECEIPTS:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Dues</td>
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<tr>
<td>Official Dues</td>
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</tr>
<tr>
<td>Proceedings</td>
<td>3,631.80</td>
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<tr>
<td>Reprints</td>
<td>1,917.19</td>
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<tr>
<td>Foreign Animal Books</td>
<td>544.04</td>
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<tr>
<td>Registration Fees</td>
<td>22,360.00</td>
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<tr>
<td>Tours</td>
<td>1,139.34</td>
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<tr>
<td>Interest Income</td>
<td>949.36</td>
</tr>
<tr>
<td></td>
<td><strong>55,721.73</strong></td>
</tr>
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TOTAL BEGINNING BALANCE and RECEIPTS $63,829.25
UNITED STATES ANIMAL HEALTH ASSOCIATION
1910 BYRD AVENUE, ROOM 118
RICHMOND, VIRGINIA 23230

STATEMENT OF CASH RECEIPTS and DISBURSEMENTS FOR
PERIOD OCTOBER 1, 1975 through SEPTEMBER 30, 1976

DECREASED BY EXPENDITURES:

Annual Meeting $ 5,289.94
Printing 18,643.06
Office Supplies 1,883.13
Salaries 12,218.38
Social Security Tax 1,254.78
Communication 3,129.72
Travel:
   Dr. J. C. Shook 645.95
   Dr. W. L. Bendix 1,232.31
   Dr. T. F. Zweigart 444.02
   Dr. Harry E. Goldstein 615.36
   Ella R. Blanton 122.89
Rent—Office Space 1,209.96
American Association of Veterinary Livestock Diagnosticians 5,000.00
Virginia Unemployment Insurance 52.90
Surety Bond—Treasurer 50.00
Miscellaneous Expenses 562.75
Bank Service Charges:
   Southern Bank and Trust Company
      Richmond, Virginia 42.43
   Trevose Savings and Loan Association
      Morrisville, Pennsylvania 1.00
   Sandia Savings and Loan Association
      Albuquerque, New Mexico 1.00

$52,399.58

CASH BALANCE—SEPTEMBER 30, 1976:

Cash on Hand—September 30, 1976 $ 531.11
Southern Bank and Trust Company
   Checking Account 34.65
   Savings Account 10,868.91

11,429.67
UNITED STATES ANIMAL HEALTH ASSOCIATION
1910 BYRD AVENUE, ROOM 118
RICHMOND, VIRGINIA 23230

SUMMARY OF OPERATIONS
FOR PERIOD OCTOBER 1, 1975 through SEPTEMBER 30, 1976

REVENUE:
Total Cash Receipts $ 55,721.73
LESS—Expenditures 52,399.58
Excess of Receipts over Expenditures $ 3,322.15

NET WORTH—September 30, 1976:
Cash on Hand—September 30, 1976 $ 531.11

Balance:
Southern Bank and Trust Company
Richmond, Virginia
Checking Account 34.65
Savings Account 10,863.95
Accounts Receivable 12,207.97
Petty Cash Fund 25.00
Deposit—C. and P. Telephone Company
Richmond, Virginia 100.00
Inventory—Supplies and Proceedings 12,000.00
Furniture and Fixtures 1,861.63

NET WORTH—September 30, 1976 $ 37,624.31
UNITED STATES ANIMAL HEALTH ASSOCIATION
1910 BYRD AVENUE, ROOM 118
RICHMOND, VIRGINIA 23230

ANALYSIS OF CHANGE IN NET WORTH:

Net Worth—September 30, 1975 $ 17,108.75

Increased by:

- Accounts Receivable 11,097.07
- Inventory—Supplies and Proceedings 5,500.00
- Furniture and Fixtures 596.30
- Savings Account 3,083.62
- Cash on Hand 393.66

$ 37,779.39

Decreased by:

- Checking Account 153.08
- Savings Accounts:
  - Trevose Savings and Loan Association
    Morrisville, Pennsylvania 1.00
  - Sandia Savings and Loan Association
    Albuquerque, New Mexico 1.00

$ 155.08

NET WORTH—September 30, 1976 $ 37,624.31

Henry H. Budd, Accountant
UNITED STATES ANIMAL HEALTH ASSOCIATION
1910 BYRD AVENUE, ROOM 118
RICHMOND, VIRGINIA 23230

FOR PERIOD OCTOBER 1, 1975 through SEPTEMBER 30, 1976

ANALYSIS OF MISCELLANEOUS EXPENSE:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditing Books</td>
<td>$250.00</td>
</tr>
<tr>
<td>Dues—Dr. W. L. Bendix, (A. V. M. A.)</td>
<td>75.00</td>
</tr>
<tr>
<td>Contract Labor</td>
<td>124.00</td>
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<tr>
<td>State of Delaware—Charter</td>
<td>107.75</td>
</tr>
<tr>
<td>Rent—Safe Deposit Box</td>
<td>6.00</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$562.75</strong></td>
</tr>
</tbody>
</table>
I am always happy to welcome this group to Florida. I know you are well aware the Miami Beach and Collins Avenue are not really representative of Florida but it is the scene associated with our state by many of our northern visitors so I hope that you will have an opportunity to see "the other Florida" and take a more accurate picture of our state home with you.

I know that you have had a busy day and will be busy until about noon Friday and so I will keep my remarks on the brief side tonight.

But I do want to tell you how important I feel your organizations are to our livestock industries, and I hope that you will help us to make further progress in protecting our animal industries. We have major tasks facing us. Pests and disease do not recognize any time outs and our job—as scientists and regulatory officials—is to do the very best we can that livestock producers can have some protection from them.

I recall that in the 1972 meeting, I was very proud to tell you that Florida agriculture was a booming, vibrant industry, with cash receipts of some $1.5 billion a year. Well, I take even greater pride in the fact that our state's agriculture—even with a depressed livestock industry—now has exceeded $2.4 billion. And we are going to do do even better this year.

All facets of our multi-faceted agriculture are gaining over last year. Total income from sales of livestock and livestock products in 1975 reached a record of about $625 million, even with depressed prices for cattle and hogs. This was 15 percent over the preceding year as our livestock producers moved more animals to market to reduce a burdensome inventory and try to improve the price.

Agribusiness is much more than raising cattle and hogs, or vegetables or field crops. It embraces marketing, transporting, warehousing, processing and many other aspects of the food business as well as providing our clothing and timber needs. This all told in Florida amounts to some $10 billion or more in our economy per year, and provides one out of every three jobs in Florida.

It is our most important industry. We appreciate, of course, the tourist business for which Florida is famous and adds many dollars to our economy too. You've heard the slogan, "Keep Florida Green; Bring Money." And it is important that our economy rest upon a
wider base than a single industry. But when economic problems occur as we have seen, and the tourist industry fades, our agriculture is there to maintain our prosperity.

But our agriculture needs and must have protection, and on that subject, Dr. Mulhern, I am very encouraged that our country recently joined with Canada and Mexico—in fact you signed the agreement for us—to fight the harmful plant pests that we now share and to guard against any introduction of new ones to the North American Continent. The North American plant protection agreement was a great step forward and I hope you are working on an animal pest agreement.

I know also that the Animal and Plant Health Inspection Service is working closely with Mexico under a 1972 agreement establishing a joint Mexico-U.S. Commission for the eradication of screwworms. I appreciate the cooperative attitude of both governments in dealing with this very serious problem. The U.S. infestation exists in Texas—we do not want it again in Florida.

Under the 1972 agreement, a new sterile screwworm fly center is functioning in Southern Mexico and just eight weeks ago, more than three million screwworm flies, raised and sterilized at the center, were released over infested areas in the Southern part of the Baja Peninsula.

Commission members estimate eradication of the destructive livestock pest will be possible in five to seven years.

Plant and animal pests do not recognize state and national boundaries and I am hopeful that the new agreement with Mexico and Canada can help the United States and its agricultural producers obtain protection.

Dr. Mulhern, I am sure every livestock producer in Florida and all over the South will agree that Brucellosis is probably our number one problem. I am hopeful that sessions of concerned committees meeting here this week will produce a workable program that will allow us to clean up this dreadful problem expeditiously.

We can't afford to live with this disease any longer than we have to, and, thank goodness, we don't have any hog cholera and hope never to have any again. It is unfortunate that there have been recent outbreaks in other states.

I think it also was unfortunate that the bids received this past summer for construction of the Fleming Key Animal Import Quarantine Station down near Key West were above the authorized appropriation and the specifications had to be revised. This is delaying the operation of a facility for which we have hoped to have for a long, long time. I understand the U. S. Department of Agriculture
will be readvertising this month and hope to award a contract in December.

The process of importing improved bloodlines of breeding stock from Europe, where some very desirable cattle are raised, is just too expensive and burdensome on domestic producers, and we hope possibly by 1979 to have the import station on stream to make those bloodlines more readily available without fear of harming our domestic herds. Incidentally, we appreciate the USDA spending six million dollars in Florida and particularly in the Keys. It will help the economy down there.

Regarding the Quarantine Station, I would like to tell this audience that our own Senator, Richard Stone, a city boy originally from Miami, worked very hard for the American Livestock Industry to push the approval through and has kept behind the project ever since he went to Washington. He is doing a great job for agriculture as a member of the Senate Agriculture Committee.

Now, in view of all the activity we have left on our program this evening, and our need to get on with it, let me say to you how glad I am to have this prestigious group meeting here in Florida and to repeat my sincere welcome to Florida. At least, it got some of you out of the snow for a few days.
RESPONSE TO WELCOME

J. G. Flint
St. Paul, MN

President Goldstein, Commissioner Conner, members of the United States Animal Health Association, members of the American Association of Veterinary Laboratory Diagnosticians, and Guests:

To use a rather time-worn expression, but one that so aptly describes the situation, it is a privilege and a pleasure to respond to Commissioner Conner's Welcome—a privilege to respond and a pleasure to be here at the 80th annual meeting of USAHA and the 19th annual conference of AAVLD. I am sure that those who have not been here before have been looking forward to this occasion and others of us are most happy to return.

Commissioner Conner gave us an excellent and very thorough run-down on the attributes of the Sunshine State in his welcome address four years ago in 1972. Dr. W. E. Lyle, who gave the response that year, pointed out that the Commissioner had not mentioned one of the state's more intensive farming enterprises—the cultivation and harvesting of tourists—and I might add to that, convention-goers. This is the third time this group has met in Miami Beach—1958, 1972 and now this year. Obviously Dr. Campbell is doing an outstanding job in more than just the field of animal health—congratulations, Clarence!

This is the first time that I have had the honor of responding to the Welcome Address given by a representative of the host state, whereas at the meeting in Oregon last year, Dr. Campbell gave the response and stated that it was the third time that he had been so honored by the program committee. I assumed that this was because he is such an accomplished and fluent speaker—a fact that I'm sure none of us will contest. You can imagine how pleased and flattered I was when Ella called the last week in August and asked if I would give the response this year. After being a member for 17 years, the Association had finally gotten around to recognizing my hidden talents! But—I didn't let well enough alone. I had to ask "Why me?" And Ella told me why—the individual picked is a representative from the state that will host the meeting the next year. I almost missed out there, too, because as most of you know, Minnesota won by default when the facilities at Rapid City, South Dakota were deemed inadequate and those under construction would have been too expensive.

Florida is indeed a wonderful state as you have already heard here tonight. And, of course, this weather is something else. Back in Minnesota we stopped having weather like this two months ago. The
meeting in Minneapolis next year starts on October 16 and it could be cool or even brisk at that time of year. We define cool as above freezing, brisk as from there down to zero, and below that we have to admit that it does seem cold. Year after year I have heard speakers refer to this as a working meeting, and I guess we would have to agree. The 1975 Proceedings lists 32 committees and all of them will be meeting here in the next four days, some of them scheduling two or more sessions. But along with that work there must be some time for relaxation and enjoyment—else why would we come back to this beautiful area for the third time? So, Commissioner, I guess I can assure you that we intend to work, but there is also the old saying that all work and no play makes Jack a dull boy—and this is one Jack that does not intend to get dull from overwork if at all possible, so we are going to take the time to enjoy your wonderful state, its recreational and scenic facilities—and its weather—and still make this one of the best meetings yet.

In closing, I would like to say that we in Minnesota are looking forward to seeing all of you in Minneapolis next October.
A CHALLENGE AND A PRESENTATION

F. J. Mulhern*

As I watched the recent debates, I recalled a point being made at a management seminar that I recently attended when the speaker emphasized that one characteristic of a leader is his ability to conceptualize. He explained its the ability to see the big picture and its component parts, and how those parts interrelate like in a mosaic. This quality is necessary in order for them to lead us thru the frustrations of today's times.

The challenge to most of us in this room is to see the big picture that confronts us in the area of animal health or meat and poultry inspection. The same challenge applies to whatever stage we are in our careers, whether we are leading a few people or many, or even the President of the United States who leads 230,000,000. In order for people to give their support and commitment to the leader they must believe in him or her, know what part they play in the total picture and what they can do about it.

Let's look at the so-called mosaic of the USAHA. I'm not going to identify all parts of it but let me show just a few.

What I'm asking you to do is think of all the parts as you know them and consider how they interrelate or better interact. If they interact perfectly we get a clear picture; if they don't its distorted. Or put it another way, if they interact effectively we get progress and if they don't, we get confusion and little or no progress.

Have you ever been in a meeting with officials from foreign countries and explained how the interrelationships between State and Federal government officials occur in our cooperative programs? You can tell there is either disbelief or bewilderment in their eyes as one relates the story.

It is especially difficult to convince the communist countries, the socialist countries and even those in the western world like Australia where the six individual states dominate the rule of the country in animal health programs.

Personally, I like nothing better than the system that we have in the United States. This system is considered by outsiders to be both cumbersome and complex. I'm sure those who have been involved in bringing about harmonious and effective working relationships between the different countries of Europe in regard to the EEC plan

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*Administrator APHIS
wonder if it will ever work effectively. We have a big advantage though and that is we speak a common language—at least most of the time. Also, even though we have different cultures in our region's that contrast is not as great as between the countries of Europe.

If we place the United States of America on the western part of France, the eastern border would be in Russia as shown in this slide. If they are having trouble getting just a few of those nations to relate effectively for the common good, we don't need to be discouraged by any problems we have between our 50 States.

Another point to put in proper perspective is that sometimes I hear people say, “Well, this country did it, why can't we”, and my immediate reaction is that they are comparing that other country to a similar situation that has been or could be accomplished by one of our States and in many cases the area and human or livestock population may be far less than some of our States.

What I'm trying to say is that with all of its faults, we have one beautiful system and you better believe it.

What is that system to which I am referring? Well, first, there isn't a better example in my opinion of effective State-Federal relations than what takes place at this meeting. We really develop action plans and not just a lot of rhetoric. Let's stop and ask ourselves do we really appreciate what takes place here?

I have been at several congressional hearings in my career and I don't think that all members of Congress truly appreciate what goes on here between the representatives of the State and Federal governments and the industries that are involved. Otherwise, they wouldn't be talking about the burdening Federal program or the dominating Federal program. They just don't appreciate that through this organization State and Federal interests blend into programs that have the support of both sides and that industry views are sought and reacted to in an effort to get maximum commitment.

Thus, when we agree to a certain approach, we call them uniform methods and rules—those become the guidelines to follow and take on more meaning when they are developed into State and Federal regulations. We, the State and Federal governments, take those uniform methods and rules seriously but those outside have very little appreciation for their importance. Generally because the image of most people is that Federal programs are shoved down States' throats.

I'm not naive enough to believe that Federal authority in these programs doesn't hover over the activities of the States in our cooperative programs but historically it is used very seldom and I can't remember using it when we didn't have the majority of the States supporting it.
If you review the proceedings of this organization you will readily see that programs take circuitous ways to reach their goals. This is absolutely necessary in order to fit programs into the uniqueness of the various States and particularly to the regions of our country.

Some people tend to belittle compromise, but it is absolutely vital for our country to be progressive as it has been. One document that we are all so proud about is the "Declaration of Independence" and there isn't a better example in the world that exemplifies the results of compromise when all are seeking an answer and have a common goal of reaching a solution for the good of all the people in the 50 States.

Compromise comes hard when people are looking for what is the best solution to a problem. If you don't believe it, go into some of these committee meetings this week and listen to both sides of the issues. We live in a rapidly changing society and our agribusiness that you and I relate to is changing as fast as any other part that creates different problems than we have ever had to overcome in the past. However, it doesn't create insurmountable problems.

Brucellosis is a splendid example of what I am talking about. The industry involved and the regions which are having the greatest problems are giving us a message loud and clear. That is—we are for your goal of eradication but we must come up with a practical method of achieving it. Some believe that is a negative statement because they don't see a practical method and thus react negatively to the challenge—we must find a way that the heavily infected States can reduce their infection and have a minimum adverse effect on their industry which especially at this time, is enduring dramatic financial problems.

In any of these programs we never have the answer to all the technical problems but we spend a great deal of time and effort trying to acquire them. If you want to see this in action visit veterinary laboratory diagnostic sections. Or visit the different committees that discuss the research needs of each program or go into the general session and listen to the papers being given.

In these technical areas we must have respect for all sides of the issues until they are resolved by facts through research. In carrying out my responsibility as Administrator of APHIS which has both plant and animal programs I have been deeply involved in the areas of residues. In my opinion we have been carried away by the minority views which is leading us down the wrong path. I'm a firm believer that the majority given the same set of facts most of the time will come up with a better decision than that of the minority. We need to listen to the minority views and truly evaluate them but the fact that it is a minority view means we need to be extra cautious in our evaluation.
The proceedings of the meeting are looked upon with great esteem by the government veterinary services of the world. Nowhere is there a document that provides more valuable information from a regulatory veterinary medicine standpoint than the proceedings of this organization.

Finally, let me dwell on State-Federal relations. Some of my own people have been critical of my direction because they claim that I have leaned over backwards to get along with the States to the detriment of the Federal role. I firmly believe in a strong Federal government, but I also believe in strong State government. I believe the Federal must dominate at times when situations warrant it but this should be seldom in our country. I think that both can be strong without detriment to the other. They should complement each other and not be opposed in their aims. I have seen the results of these good working relationships in the past twenty five years that I’m a firm believer in them. If we work at making both governments more effective and responsible the whole country will benefit.

In the time that I have been closely associated with this organization, I have developed great appreciation for the improved quality of State government, in the animal health and meat inspection areas. Also, since we work with the State Departments of Agriculture on cooperative plant pest and disease programs I likewise respect their capabilities.

If you just want to see dramatic improvements look at the accomplishments of the State veterinary diagnostic laboratories. I believe that we have also done an outstanding job in improving the competency and facilities at our diagnostic and veterinary biologics laboratories at Ames, Iowa. It is a splendid example of how State and Federal laboratories complement one another. I am disappointed that we have not been able to get more funds for the reference work being done at the laboratory at Ames.

Many of you were involved in the recent realignment of Veterinary Services. The logic behind such a move was for the Federal service to take more responsibility in the area of epidemiology and the States to take over more of the day-to-day testing, getting animals vaccinated, etc. It is recognized now that it was premature and so we are in a readjustment phase. Eventually I believe such a relationship will develop, but apparently not for some time.

If you will go back to past proceedings, you will note a President’s address by John Safford of Montana in which he recommended such a change. I think we will come to a time when we won’t be concerned about who is doing what because each government will have more than it can do to carry out its responsibilities.
To me, spending time belittling either form of government just shows that we don't see the big picture. Sure we will always have differences and both forms have strengths and weaknesses. I have seen us use these to the best advantage of both sides.

I foresee great changes in the work that we will be doing in the next 10 to 20 years in our area of work. As our society changes it affects all of us and so adjustments in how we carry out our job are necessary.

Our involvement in humane care of animals is a good example and I'm sure this movement will continue to have an impact within our society. We will see more emphasis being directed at how we house our livestock and poultry. I notice that there are already international meetings that were being held by humane society interests to review the conditions produced by housing poultry.

In addition, I have been told fewer new veterinary graduates are going into large animal practice. I have also been told that livestock owners find it more difficult to get practitioners to provide them veterinary services to vaccinate their animals, etc. Some solution to this problem may become necessary and veterinary services provided by State and Federal agencies may be necessary to fill this void.

If we are going to meet the challenge of the future, we must continue to place high priority on technical competency. Therefore, we must rely heavily upon our research and veterinary diagnostic laboratory colleagues. The participation by some of the leading scientists in the committees of this organization should continue to provide the high quality involvement that will be necessary.

This organization has a great history. It has had some great leaders and some real characters. There were still many of them around 25 years ago—Robbie Smith, Ralph West, Hugh Curry, Arthur Boyd, C. E. Kord, Wilkins and Ralph Hendershott, to name a few. State-Federal relationships have not always been harmonious but I believe there has always been general respect for each others responsibility.

It is probably the use of an old cliche but the leaders in this organization in the future will have it more difficult than their predecessors as they find it necessary to adjust to the changes within our society, and adjust the programs accordingly. I feel the challenge will be met. This organization conducts a meeting that allows State and Federal government personnel, the industries involved and the research and laboratory diagnostic personnel to review what we have done since the last meeting, identify what needs to be done to improve our efforts and set our goals for next year. To me, this type of relationship is a good example of "Democracy in Action". We may have many differences and problems, but we are willing to
recognize them and go on. I hope that all here will recognize their personal responsibility to make this organization a better one and at the same time respect what it has done. We must never forget that our common goal is to produce safe and wholesome meat and poultry for the people of this country and that goal is more important than any part of our individual interests. As both of the presidential candidates said in their debates, it's the people that count and we better believe it.

We do have a major flaw in our outlook in this country and that is we seem to be more prone to criticize what is wrong than we do recognize what is good about it. The record of the past has established the organization's accomplishments and its worthwhile contribution to the health of our livestock and poultry as well as protection to our public health. It provided the basis for eradicating Foot and Mouth Disease nine times, eradicated contagious pleural pneumonia, Texas Fever dramatically reduced incidence of bovine tuberculosis, the same can be said for Brucellosis, eradicated sheep scabies, eradicated screwworm from the southeast and pushed the incidence to the Texas-U. S. boundaries eradicated Vesicular Exanthema, Venezuelan Equine Encephalomyelitis Exotic Newcastle Disease in poultry, etc. In addition, we have the best veterinary biological services in the world and the same can be said about our Meat and Poultry Inspection Services. The accomplishments of our laboratories and research has been renown. Since 1929 we have kept Foot and Mouth Disease out of the United States which is no minor feat. It's a tribute to all those responsible for it. I could go on, but I want to make a point that State and Federal governments, Universities and Industry working together do get things done. However, the organization can't rest on its laurels. It must meet the challenge of our times. Whether it does or not will depend upon how much you and I individually and collectively are willing to become involved and committed to its objectives to produce the most effective veterinary regulatory programs in the world.

Knowing this organization and most of you personally for many, many years, I am extremely optimistic and confident that this challenge will continue to be met.
Distinguished Guests, Ladies and Gentlemen

It is my sincere pleasure and honor to have this opportunity to address you as President-Elect of this organization. Having been a member of the Executive Committee for the past 17 years, I have had the opportunity to observe the many problems confronting this organization and the resolution of some of those problems through the excellent leadership of past Presidents. However, one problem that continues to persist is adequate financial income to the Association. This problem is of long standing as evidenced by the concern expressed by presidents of this organization over the past several years with each having suggested increasing membership. The 1975 Committee on Professional Relations has addressed itself to this problem with the following conclusions and recommendations: quote;

"The major interest of the Professional Relations Committee is to activate USAHA to inform the segments of the livestock and allied industries and the veterinary profession of the activities and accomplishments of the USAHA. Increased emphasis needs to be directed toward disseminating this information, in that, the deliberations and resolutions of the USAHA are not completely reaching all segments of the industry.

More effective distribution of USAHA activities would result in greater support for the organization of this objective, the committee recommends that the Board of Directors of USAHA consider methods and means of publicizing USAHA.

The Committee recommends:

(a) The use of a trained Information Specialist for a period prior to and after the meeting to aid in publicizing the oncoming meeting and the organizations activities during and following the meeting.

(b) The continuation of the newsletter on a monthly basis, circulation to include livestock organizations not now members of USAHA.

(c) To finance the above, the committee recommends that $2.00 of every members dues be ear-marked for this purpose.” Unquote.

These recommendations, when implemented, should expand our image and provide this organization with due recognition for its efforts in the field of animal health over the past 79 years; however,
there is some doubt whether increasing membership alone will provide adequate funds in view of todays and tomorrows inflationary rise in costs. The greatest single item cost confronting us is the printing of our “Proceedings” which is in the vicinity of $14,000.00. Since our “Proceedings” are invaluable to much of the scientific community, as evidenced by requests for copies from many nations throughout the world, we proposed to our Board of Directors the idea of approaching philanthropic organizations for their financial support in the printing of our Proceedings. Our Board of Directors responded favorably to this proposal, therefore, we will pursue in this direction. Should we succeed, we believe funds would be available to fully implement and expand the recommendations of the Professional Relations Committee.

Another problem of concern to this organization at this time is the national brucellosis eradication effort. We can foresee difficulties in achieving total eradication under the present provisions of the Uniform Methods and Rules. Having been a member of the Brucellosis Committee for many years we are prone to accept the fact that the present program procedures were designed basically for areas of the country where cattle are readily available for frequent testing and calfhood vaccination at ages 2 to 6 months. The program does not specifically provide for procedures conducive to eradication under range and semi-range conditions. APHIS has sponsored a team of experts, known as the Brucellosis Technical Commission, to conduct an in depth review of our present eradication program with recommendations on the feasability of eradication and possible alternative approaches to the problem of brucellosis. At the Hearings before the Sub-committee on Department Operations, Investigations and Oversight House Committee on Agriculture on June 28, 1976, held in Washington, D. C., that Committee was advised that the Brucellosis Technical Commission study will be completed in about two years followed by an evaluation of their findings by the National Academy of Science. We do not believe the eradication program can remain stagnant for two years, therefore, without prejudging the Technical Commission it is incumbent on this organization through the Brucellosis Committee to examine the areas of incompatibility that may exist in the present eradication program versus eradication under conditions affecting the beef growing industry. During this interim, those of us who have achieved Brucellosis Certified Free Status must be patient and tolerant as long as complete eradication can be achieved within the proposed time frame.

As President-Elect, I would like to take this opportunity to commend the Regional Emergency Animal Disease Eradication Organization Hog Cholera task force for their success in the rapid eradication of the hog cholera outbreak in New Jersey and New England. Since most recent hog cholera outbreaks can be attributed to swine opera-
tions feeding garbage, it would appear that a recommendation to APHIS might be in order for considering restrictions in the inter-
state movement of garbage fed feeder swine. Such restrictions would minimize interstate exposure since interstate sale of feeder swine from garbage feeding operations does exist.

Much concern has been expressed by State officials regarding the inefficiency in the use of Federal personnel assigned to the various states due to the line item budgeting procedure adopted by the Office of Management and Budget. With the severe manpower restrictions placed on governmental agencies, it becomes more critical for cross utilization of Federal and State personnel in the various animal disease activities within any given State regardless of whether such program has or has not been budgeted by Veterinary Services; therefore, it would seem logical to seek changes in this area to overcome some of the problems arising due to Federal manpower shortages.

Salmonellosis has been a topic of concern to governmental agen-
cies, the food and feed industry and consumer groups for several years. As a result of this concern and possibly to dispell the miscon-
ception that USAHA is a one week a year working organization, Dr. Harry Goldstein had requested the USAHA Salmonellosis Committee, last year, to organize a Salmonellosis Symposium to be sponsored by USAHA and to seek co-sponsorships. To date, response for co-sponsorship has been gratifying and those having approved to co-sponsor this symposium at this time include; FDA, USDA, AVMA and the U. S. Airforce. The symposium is tentatively planned for November of 1977 in Washington, D. C.

There are many problems and areas of concern confronting our organization for the ensuing year; however, with your cooperation and assistance, which we will seek, and with the able leadership of our Committee chairman we have reason to believe that our problems will be resolved and our concerns alleviated.

At this time, I have an extremely pleasant chore to perform which is the presentation of mementoes to President Dr. Harry Goldstein as a token of appreciation for his leadership and direction of this Association during the past year.
PRESIDENT'S REMARKS

Harry E. Goldstein, DVM
Columbus, OH

“I sincerely thank you for this recognition serving as President of the United States Animal Health Association. We were elected second vice president in Miami Beach so it is most fitting that we finish our term at this meeting.”

“There are many plaudits that need to be made. I want to thank the committee chairmen for serving this year. Committee chairmen are the backbone of this association. I want to thank the executive committee for all the cooperation demonstrated as well as the officers for all their help and assistance. Dr. Bendix and Ella Ruth have once again carried us through another year.”

“I want to thank my dear wife, Ann, who over my 30 years in regulatory activities has always been a large part of my desire to accomplish goals and objectives.”

“When we adjourn this meeting, the affairs of this association will be in most capable hands with Dr. Al Janawicz, and I for one pledge total support to him and the association.”

“I thank you all most sincerely.”
REPORT OF THE COMMITTEE ON NOMINATIONS

Chairman: J. F. Andrews, Atlanta, GA


The U.S.A.H.A. nominating committee in session November 8, 1976 presents the following names for association offices:

PRESIDENT _______________________________ ———— —— Dr. A. E. Janawicz
                                            Vermont

PRESIDENT ELECT __________________________ ———— —— Dr. L. E. Bartelt
                                                California

1ST VICE PRESIDENT _________________________ ———— —— Dr. T. F. Zweigart
                                              North Carolina

2ND VICE PRESIDENT _________________________ ———— —— Bart Hawkins
                                                Oregon

TREASURER ________________________________ ———— —— Dr. J. C. Shook
                                               Pennsylvania

REGIONAL INDUSTRY REPRESENTATIVES:

Northwest ________________________________ ———— —— Francis Buzzell
                                               E. S. Bryant

North Central ______________________________ ———— —— J. R. Bishop
                                                Bill Gallagher

Southern _________________________________ ———— —— J. O. Pearce
                                                Joe Finley

Western ________________________________ ———— —— Bob Laramore
                                               Olin Timm

J. F. Andrews—Chairman
John Quinn
Olin Timm
Wm. Tobin
J. C. Shook
Resolution No. 1

Eightieth Annual Meeting

Held at: Miami Beach, Florida Dates November 7-12, 1976

Source: Brucellosis

Subject Matter: Brucellosis in Cattle

BACKGROUND INFORMATION

The incidence of brucellosis in cattle has been reduced to approximately one half of one percent of the population and there is serious difficulty in eliminating the disease from persistently infected problem herds and there appears to be numerous unknown reasons for inability to locate the continuing source of infection.

RESOLUTION

BE IT RESOLVED that the United States Animal Health Association urge the Congress to increase support for USDA research in developing better diagnostic procedures and finding the possible cause for recurring infection of those herds.
Resolution No. 2

Eightieth Annual Meeting

Held at: Miami Beach, Florida

Dates: November 7-12, 1976

Source: Brucellosis

Subject Matter: Brucellosis Calfhood Vaccination

BACKGROUND INFORMATION

Inadequate numbers of cattle are resistant to brucellosis and too few calves are being vaccinated for brucellosis to increase the resistance of the national herd and large numbers of resistant cattle are needed for replacement animals in infected areas.

RESOLUTION

BE IT RESOLVED that the United States Animal Health Association here in session urge the U. S. Department of Agriculture and the Congress to provide a supplemental appropriation to implement an all out calf vaccination effort.
BACKGROUND INFORMATION

The electronic identification of livestock enhances all phases of livestock management and the Los Alamos Scientific Laboratory has been and is conducting research to develop a fifteen digit system to electronically identify and temperature livestock. This work has progressed to the point that it can be successfully completed within the next eighteen months and commercial systems, that may be incompatible and duplicate individual animal identification, are commercially available. Such duplication and incompatibility would greatly reduce the usefulness and increase the costs of using electronic identification of livestock.

RESOLUTION

BE IT RESOLVED, that the Secretary of the United States Department of Agriculture be urged to make available $100,000 for the use of the Los Alamos Scientific Laboratory in completing research and development of a fifteen digit system of electronically identifying livestock.
Resolution No. 4

Source: Rabies Committee

Subject Matter: Standardized Certificate for Interstate Movement/
Rabies Vaccination

Background Information

All states except Hawaii require either a rabies vaccination certificate or a health certificate for interstate shipment of dogs and cats. Presently, there is no standardized health certificate for interstate movement of small animals. The Rabies Committee recently developed a Certificate for Interstate Movement/Rabies Vaccination which has been recommended for national use by the Rabies Committee and the Commerce Committee, USADA, and the Association of State Public Health Veterinarians.

Resolution

Be it resolved that USADA recommends that all State Veterinarians adopt the recently developed Certificate for Interstate Movement/Rabies Vaccination and print these for use by veterinarians in their state.
Resolution No. 5

Held at: Miami Beach, Florida

Source: Sheep and Goats

Subject Matter: Foot-Rot in Sheep

BACKGROUND INFORMATION

The Committee on Diseases of Sheep and Goats of the USAHA has long stressed the need for Foot-Rot research. The National Wool Growers Association, and the National Lamb Feeders Association in their priority list has placed Foot-Rot as the disease most needing research. USDA, ARS funding has not reflected the needs of the industry, and adequate research is not being conducted.

RESOLUTION

BE IT RESOLVED that the United States Animal Health Association recommends to the USDA that funds for Foot-Rot research be increased and given top priority.
BACKGROUND INFORMATION

Recent national publicity involving exposure of puppy farms also classified as "puppy mills" with stress of inadequate care and disease conditions has involved the United States Department of Agriculture as a partner in the episode of shocking puppy farms by exhibiting a lack of funding and sufficient personnel.

THEREFORE, we strongly recommend that immediate consideration be given to INCREASE FUNDING AND PERSONNEL for Veterinary Services, APHIS, to an extent great enough to overcome the current problems existing throughout the country and to achieve compliance with the act in a prompt and orderly fashion.
BACKGROUND INFORMATION

In the year 1972, 91 cases of scabies were reported. In the year 1973, 53 cases; in 1974, 39 cases; in 1975, 49 cases; in 1976, reported cases were up to 89, with spreading to states such as Arizona, Georgia and California. The situation does not remain static, we have excellent permitted dips. We have no reason to believe the psoroptic mite is resistant to these dips. If the eradication program is properly funded and if a sufficient number of personnel are assigned, trained and properly motivated, eradication can be achieved.

RESOLUTION

BE IT RESOLVED by the USAHA that it is deemed necessary that present and future budgets of the USDA and the several states provide substantial increases for the national cattle scabies eradication program to provide for personnel and training for a more adequate, full time inspection and traceback force in the field.
Resolution No. 8

Held at: Miami Beach, Florida

Source: Food Animal Hygiene Inspection

Subject Matter: Funding for State Meat Inspection

BACKGROUND INFORMATION

The Wholesome Meat Act of 1967, the Wholesome Poultry Products Act of 1968, require states conducting meat and poultry inspection programs to be equal to federal inspection requirements. Several states have terminated their programs because of the financial costs of meeting this commitment, and many of the remaining states having meat and poultry inspection programs are facing continuing difficulties because of money problems.

RESOLUTION

BE IT RESOLVED that the United States Animal Health Association actively work for and support 80% federal funding for state meat and poultry inspection programs including the Talmadge-Aiken Cooperative Programs.
BACKGROUND INFORMATION

A number of molds and mycotoxins are associated with feeds such as grain and forages and these mycotoxins have been demonstrated to be injurious to livestock and poultry and are responsible for undetermined annual economic losses in both domestic and international trade. Certain of these mycotoxins are capable of producing residues in meat, milk and eggs and several of these mycotoxins have been identified as carcinogens and therefore represent a potential threat to the public health and welfare. There is a need to intensify research and laboratory proficiency to better evaluate the impact of mycotoxins on animal and public health.

RESOLUTION

BE IT RESOLVED that the U. S. Animal Health Association make known to the Secretary of Agriculture that there is a critical need for a comprehensive assessment of this problem to ascertain appropriate areas of research in order to efficiently diagnose, prevent, or mitigate these problems. Toward this end it is recommended that the USAHA recommend that the Secretary of Agriculture request the National Research Council, National Academy of Sciences establish an expert committee to conduct a comprehensive study and evaluation of those molds and mycotoxins of concern to animal agriculture and the public health in order to determine those research needs and preventive measures relevant to the protection of animal and human health. It is recommended that the Executive Committee communicate this resolution to other responsible and agriculturally allied groups soliciting their endorsement and support.
Background Information

The United States National Security Council has recommended that no further bids for highway construction be let until the USDA has determined that effective FMD surveillance and control programs have been established with Panama and Colombia to assist in preventing the spread of FMD during construction and upon completion of the highway. The program in Panama has made good progress and appears to be running smoothly. However, the USDA cooperative program with animal disease control authorities of the Government of Colombia has, thus far, failed to accomplish all of the objectives agreed upon between the two countries. The program is moving slowly and unless it is speeded up, it will not provide the FMD protection necessary.

Resolution

The committee recognizes that the cooperative program with Colombia to control FMD in the Darien area of Colombia has failed to achieve many of the goals established for that program be it resolved that the USDA continue to work with the Government of Colombia in attempts to establish changes in the arrangements for the cooperative program to better insure that the goals of the program can be achieved.
Resolution No. 11

Held at: Miami Beach, Florida

Source: Committee on Evaluation and Development of State-Federal Programs

Subject Matter: Increased funding and activity in the Cattle Fever Tick Eradication Program.

Background Information

Improved pastures and a cycle of more favorable weather condition in South Texas have enabled the cattle population to double. This increased livestock population and number and movement of host animals has resulted in cattle fever ticks spilling out of the area along the Rio Grande River under Federal and State Quarantine northward and threatening not only additional areas in Texas but also into other states.

The Federal and State funds and manpower available has not been sufficient to locate all of the infestations or to bring the situation under control.

Resolution

BE IT RESOLVED THAT USDA, APHIS, Veterinary Services, and the State of Texas commit sufficient funds and manpower to the Cattle Fever Tick Eradication Program to locate and eliminate the infestation outside and inside the quarantine area and prevent spread of infestation into additional states.
Resolution No. 12  

Resolution: 

Be it resolved by USAHA that USDA, APHIS, Veterinary Services, and the States involved provide the necessary funds, manpower, and infuse sufficient energy and enthusiasm into the cattle scabies eradication program to achieve full control and eradication.
Resolution No. 13

Meeting held at: Miami Beach, Florida

Source: Committee on Leptospirosis

Subject Matter: Establishment of a National Leptospiral Reference Laboratory to be supported by the U.S. Department of Agriculture.

Background Information

At least six serovars (serotypes) of leptospires have been isolated from various species in the United States livestock and additional serovars have been serologically detected in livestock and/or isolated from wildlife. Furthermore, additional serovars have been isolated in areas geographically contingent to the United States and, on a global basis, more than 20 pathogenic serovars have been isolated from cattle and swine. Each of these serovars is capable of causing significant disease losses and each has unique antigenic components that stimulate the production of protective immunity in the host. These unique antigenic components must also be identified by highly technical laboratory procedures to type a given isolate. At the present time, only one laboratory in North America has the technical capability to type leptospires, and it has primary responsibility for the protection of human health. It is imperative that a typing laboratory with primary responsibility for animal health be established to support ongoing surveillance, identification of new serotypes and control programs. This is a matter of national concern and therefore cannot be reasonably provided on a state or regional basis.

Resolutions

THEREFORE BE IT RESOLVED: that the Secretary, United States Department of Agriculture, take the necessary actions to have the Animal and Plant Health Inspection Service immediately establish a laboratory with the capabilities of a WHO Leptospiral Reference Laboratory.
If this resolution is approved by the U.S.A.R.A., copies should be sent to:

- Secretary of Agriculture
- Director of APRIS
- Director of NADC
- Director of Diagnostic Services
- American National Cattleman Assoc.
- National Cattle Feeder Assoc.
- National Pork Producers Assoc.
- Sheep Producers Assoc.
- American Association of Veterinary Laboratory Diagnosticians
- Livestock Conservation Incorporated
- American Veterinary Medical Assoc.
- Bovine Practitioners Assoc.
- Swine Practitioners Assoc.
- American Leptospirosis Research Conference
Resolution No. 14
Held at: Miami Beach, Florida
Source: Salmonella

Resolutions

BE IT RESOLVED That the United States Animal Health Association urge:

1. The U. S. Department of Agriculture and Food and Drug Administration to continue their excellent public information salmonellosis releases via radio and television as well as other news media. These do much to educate the U. S. public as to the significance of salmonellosis and its prevention at the consumer level.

2. That adequate and critically needed support be provided to continue the serotyping and diagnostic support for salmonellae activities of the National Animal Disease Center -APHIS-, Ames, Iowa and the Center for Disease Control (Dept HEW, PHS), Atlanta, Georgia. These are presently the only laboratories which provide these essential services to all of the fifty states and U. S. possessions.

3. That support be provided for the envisioned national salmonellosis reporting service in animals and poultry which is being developed by the American Association of Veterinary Laboratory Diagnosticians in conjunction with other concerned national groups.

4. That the U. S. Animal Health Association recommend and seek legislative support and funding for salmonellosis research in these critical areas which relate directly to human and animal health and well being, i.e.:

(a) Identifying sources of salmonellae in the environment, i.e. water, effluents, aquatic fauna-especially edible fish and wildlife.

(b) Assessing the role and public health aspects of salmonellosis in companion animals, i.e. house pets, including caged birds, reptiles and aquarium fishes. Salmonellosis in horses is a serious problem which has resulted in human infections.
(c) Ascertaining physiological and toxicological parameters which affect the course and outcome of salmonellosis. Such knowledge would do much in providing more effectual preventive and control measures.

(d) Assessing ways and means of breaking the transmission cycle of salmonellae in livestock and poultry.

(e) Developing more efficient, yet accurate, means of detecting and identifying Salmonella clinical cases and carrier animals.

(f) Devising adequate and safe methods for disinfection of feeds and feed supplements to eliminate salmonellae in these products fed to livestock, poultry and pet animals. It should be remembered that dog foods are sometimes consumed by unfortunates in the lower social economic groups.
BACKGROUND INFORMATION

Since 1974 there has been a marked increase in the incidence of Pseudorabies (PR) in the midwest. States reporting an increase in the number of outbreaks have been Illinois, Indiana, Iowa, Kansas, Nebraska, and South Dakota. Deaths have occurred among mature animals as well as piglets indicating increased virulence among the strains present. A high incidence of abortions and stillbirths has become a feature of the disease. High mortality among other farm animals such as cats, dogs, cattle and sheep has occurred with greater frequency. The explosive situation in the midwest has enhanced the chance of PR rapidly becoming a national menace. New states recently reporting foci of PR are: Kentucky, Minnesota, North Carolina, Oklahoma, South Carolina and Wisconsin. The devastating economic impact of PR on the swine industry is demonstrated by a recent study done on 16 farms in Hardin County, Iowa, where PR had occurred. Losses in cattle and swine from deaths and stunting totaled $143,923. In addition there was a potential profit of $288,264 for a total loss of $462,587. Producers are naturally alarmed about the threat PR poses to their herds. As an expression of their outward concern, standing PR committees have been formed by the National Pork Producers Council (NPPC) and Livestock Conservation Institute (LCI) to study the problem and make recommendations. Consideration by the United States Animal Health Association (USANA) is imminent, as a subcommittee on Pseudorabies has been formed to advise the Committee on Transmissible Diseases of Swine. These committees are composed of swine producers, regulatory and industry related officials, veterinary medical laboratory diagnosticians and other members of the scientific community.

RESOLUTION

BE IT RESOLVED THAT THE USAHA MEETING in Miami, November 12, 1976:

1. Supports the efforts of the A.A.V.L.D. Committee for Standardization of Pseudorabies Diagnostic Tests.

2. Opposes the use in this country of pseudorabies vaccine (whether it be live-virus or inactivated virus vaccine) at this time; however, support additional research on a pseudorabies vaccine in the event that such a vaccine would be useful in an eradication program.

3. Recommends that states impose appropriate quarantines on active and confirmed pseudorabies outbreaks to protect other swine producers.

4. Strongly supports the concepts of pseudorabies eradication and urges the USDA, VS, to proceed immediately with a campaign to eradicate the disease.
BACKGROUND INFORMATION

In 1971 hemorrhagic disease was first confirmed as an important disease of wild cervids in the southeastern United States, at which time bluetongue virus (BTV) and epizootic hemorrhagic disease virus (EHDV) were isolated from white-tailed deer that succumbed in seven southeastern states; Since then, hemorrhagic disease has been diagnosed annually in wild deer of the southeastern region, which strongly suggests that BTV and EHDV are enzootic throughout the south Atlantic coastal region. The status of these diseases in domestic livestock, primarily cattle, remains very uncertain with current failure to recognize this disease entity in cattle attributed to several fundamental factors. It appears that hemorrhagic disease (BT and EHD) is a rapidly emerging disease of considerable significance for the cattle industry and big game animal interests throughout the eastern United States.

RESOLUTION

BE IT THEREFORE RESOLVED, that the United States Animal Health Association, request that USDA initiate a program to define the distribution of hemorrhagic disease (BT and EHD) in cattle throughout the United States; train additional personnel in state and local laboratories in diagnostic procedures for detecting this disease entity and use every available means to have food animal practitioners become more aware of BT and EHD infections and the various forms such can assume in cattle.
Resolution No. 17

Eightieth Annual Meeting

Held at: Miami Beach, Florida

Dates November 7-12, 1976

Source: Ad Hoc Epizootic Attack Plans

Subject Matter: Swine Fed Raw Garbage

BACKGROUND INFORMATION

The feeding of raw or improperly cooked garbage is illegal or banned in every state and territory in the United States. The feeding of raw or improperly cooked garbage endangers the wildlife and livestock population of the United States, and yet the illegal feeding of raw or improperly cooked garbage continues in spite of state and federal efforts to effectuate the state laws and federal regulations aimed at preventing the spread of diseases of swine. The owners of raw garbage fed swine are asking relief to allow those animals to move interstate for slaughter, which could result in widespread outbreaks of diseases of swine. The approval of the proposal to allow raw garbage fed swine to move interstate for slaughter would definitely encourage more producers to feed raw garbage.

RESOLUTION

BE IT RESOLVED, that the United States Animal Health Association (USAHA) urge the Secretary of Agriculture to continue the current federal regulations prohibiting the interstate movement of swine which have ever been fed raw garbage and to seek national legislation to strengthen that prohibition.
Malignant Catarrhal Fever (MCF) is a serious viral disease of cattle and other animals in Africa. A similar disease exists in the United States, but no etiologic agent capable of reproducing the classical disease has ever been isolated from cases in the United States.

BE IT RESOLVED, that the United States Animal Health Association encourage State and Federal agencies to make extensive efforts to isolate the causative agent from MCF cases in the United States so comparative studies can be made with the virus isolated from MCF cases in Africa to determine if the United States and African diseases are caused by essentially identical or different agents.
BACKGROUND INFORMATION

WHEREAS, through an unprecedented joint effort between the United States and Mexico during the late 1940s and early 1950s, a major outbreak of Foot and Mouth Disease (FMD) was contained and eradicated from the North American Continent at a cost of 136 million dollars to taxpayers of both countries;

WHEREAS, reintroduction of FMD into Panama and Central and North America would exert a disastrous effect on the entire livestock economy of this continent, with likely involvement and subsequent necessity for slaughter of big game animals and other wildlife species from coast to coast;

WHEREAS, the Federal Highway Administration's plans for constructing a 200 million dollar road through portions of Panama and Colombia to connect the North and South American Continents, threatens to create a dangerous corridor for reintroduction of FMD onto the North American Continent;

WHEREAS, from studies conducted in 1975 by the National Research Council, it is predicted that as a consequence of this construction FMD will be introduced every 6 years into Middle America with average costs to USDA for eradication of the disease conservatively estimated at 20 million dollars per annum;

WHEREAS, on September 24, 1976, the International Association of Fish and Wildlife Agencies adopted a resolution that opposed completion of the Darien Gap Highway until such time that the Secretary of Agriculture devises a program to insure that Foot and Mouth Disease cannot be introduced into the United States through this land route;

WHEREAS, on October 28, 1976, USDA's Advisory Committee on Foreign Animal Diseases recommended that the Secretary of Agriculture insist upon environmental and economic impact statements adequately addressed to the effect and cost/benefits to be derived from the proposed Darien Gap Highway; and

WHEREAS, the United States Animal Health Association (USAHA) shares this vital concern for diseases affecting domestic and wild animals of North America, concomitantly with similar concern for indiscriminate spending complemented by disregard for the impact that such will have on the national economy;

RESOLUTION

IT THEREFORE IS RESOLVED, that USAHA support USDA's Advisory Committee on Foreign Animal Diseases in urging that the Secretary of Agriculture insist upon preparation of an Environmental Impact Statement adequately addressed to the effect of the proposed Darien Gap Highway on potential spread of foreign animal diseases and parasites to countries north of the Darien Barrier; and

IT IS FURTHER RESOLVED, that USAHA support USDA's Advisory Committee on Foreign Animal Diseases in recommending to the Secretary of Agriculture that responsible agencies prepare an Economic Impact Statement relating to cost/benefits to be derived from completion of the Pan American Highway through the Darien Barrier.
Resolution No. 20

Held at: Miami Beach, Florida

Dates: November 7-12, 1976

Source: Zoological Garden Committee

Subject Matter: Post Entry Controlled Animals

Background Information

WHEREAS, existing laws do allow progeny of post entry quarantined animals to be moved without any restrictions.

WHEREAS, contact animals are also free of restrictions on movement.

WHEREAS, improved diagnostic tests and techniques can determine with much greater accuracy the presence of latent disease agents.

WHEREAS, after a period of residency it would be advantageous to the preservation of the species by allowing movement of these imported animals to other Zoos for breeding purposes thereby increasing the gene-pool base of the species among the various zoological parks.

Resolution:

Be it resolved that the Committee on zoological gardens, USAHA, recommends that USDA, APHIS, Veterinary Services initiate an amendment to the import-export laws stated in Sec. 306 (a) tariff act of June 17, 1930, 19 USC 1306 to allow a change in the requirements for post entry controlled without impairing or decreasing the present precautionary measures of preventing introduction of foreign or exotic diseases into the United States.
Resolution No. 21
Held at Miami Beach, Florida
Source Ad Hoc Epizootic Attack Plans
Subject Matter Cattle Fever Ticks

BACKGROUND INFORMATION

WHEREAS, during the latter part of the 19th Century, a mysterious malady was imposing staggering financial losses, which at that time were estimated at 40 million dollars annually to cattlemen of the mid-west;

WHEREAS, since this insidious sickness became conspicuous when Texas cattle were driven to the great railheads of the West and coincided with death of countless thousands of northern cattle, the entity became known as Texas Cattle Fever;

WHEREAS, in 1887 it was recognized that previously contaminated pens, barns, and pastures were dangerous during the warmer months, but from the first heavy autumn frost through the last severe spring frost, this disease was rare;

WHEREAS, in 1893, a protozoan (Babesia bigemina) and a one-host tick (Boophilus annulatus) were concomitantly incriminated as factors causing this costly disease, whereby the arthropod vectors were referred to as Texas Cattle Fever Ticks;

WHEREAS, by the early 1900s fever ticks had become spread throughout most southern states, which posed an ominous threat to the livestock economy of this region as carriers of the deadly cattle disease, piroplasmosis;

WHEREAS, dipping was deemed to be a feasible approach for conducting a national cattle fever tick eradication program, in 1906 the mammoth project was inaugurated by the Bureau of Animal Industry of the U.S. Department of Agriculture;

WHEREAS, after expenditure of millions of dollars, fever tick eradication was successful until 1931, when "breaks" occurred in Florida where white-tailed deer were incriminated as hosts for B. microplus, the tropical counterpart of B. annulatus;

WHEREAS, as a consequence of these findings over twenty thousand wild deer were annihilated as part of the national fever tick eradication effort resulting in tremendous loss of that resource in the State of Florida;

WHEREAS, at present all states are free of fever ticks with exception of Texas, where both B. annulatus and B. microplus are entrenched in the southern portion of that state and threaten to break out of the quarantine zone; and

WHEREAS, cattlemen of Texas are sharing the brunt of burden and responsibility in combating this threat to a significant segment of the livestock and big game animal resources of the United States at a tremendous expense to many individual ranchers.

RESOLUTION

NOW, THEREFORE BE IT RESOLVED
That the U.S.A.H.A. strongly urges the U. S. Secretary of Agriculture to declare that an emergency exists in regard to cattle fever ticks which threatens the entire nation.
BE IT FURTHER RESOLVED

That cattle imported from Mexico be handled in the following manner:

1. Be branded and not permitted to enter any area designated by State and Federal regulatory officials as a tick infested area.

2. As soon as possible inject Mexico cattle with a prophylactic for the babesia. If approval from FDA is required, then steps should be initiated to get this approval.

3. As soon as feasible institute testing for piroplasmosis and rejecting entry to positive reactors.

BE IT FURTHER RESOLVED

That the objective of all the foregoing shall be to protect the U. S. livestock industry from entry of piroplasmosis and to achieve eradication of the Boophilus tick from Texas at the earliest possible date.
Resolution No: 22  
Held at: Miami Beach, Florida  
Source: Committee on Import-Export  
Subject Matter: Calling for additional research on the methods of diagnosis, control and if feasible, eradication of Blue Tongue.

Background Material  
The presence of Blue Tongue in the U.S. is adversely affecting the U.S. balance of trade. Embargoes have been placed on cattle, sheep and semen by several foreign countries. Some of these countries are in desperate need of some products, especially semen, but will not risk the importation of Blue Tongue.

Although known to exist in certain areas of the U.S., its general distribution and the degree of infection in these areas is not known. The efficacy of the tests are suspect by some. The American National Cattlemen Association strongly urge and support the following resolution.

Resolution  
BE IT THEREFORE RESOLVED that the U.S.A.H.A. recommend and urge that the Secretary of Agriculture provide the necessary resources be made available to greatly augment research on the diagnosis and control of Blue Tongue. It is further recommended that the USDA allocate the necessary resources to conduct a nationwide survey to determine the distribution of the disease in the U.S. and to develop and carry out a pilot project to determine the feasibility of a control and eradication program.
Resolution No. 23

Held at: Miami Beach, Florida

Source: Committee on Import-Export

Subject Matter: Expanded research on the efficacy and method of application of pesticides for the control and eradication of Gulf Coast ticks—Amblyomma maculatum.

Background Material

Limited trials indicate that the application of certain pesticides in impregnated materials provide almost complete control of ticks and horn flies and aid in preventing the severe inroads of Screwworm. Ear tags, earbands, tail bands and leg bands all have shown promise but none of them seem to be the whole answer. Perfection of these methods could greatly enhance the solution to some of the great parasite problems related to livestock.

Resolution

BE IT RESOLVED THAT funds, facilities, and research effort be made rapidly available on a large scale for the successful conclusion of these promising trials.
Resolution No. 24

Eightieth Annual Meeting

Held at: Miami Beach, Florida

Scource: Committee on Import-Export

Dates November 7-12, 1976

Subject Matter: Calling for the declaration of an emergency to eliminate critical extensions of cattle fever tick from South Texas into other states.

Background Material

Cattle fever ticks are carried into South Texas by stray and smuggled livestock crossing the Rio Grande river from Mexico. Areas in Texas adjacent to the river are patrolled by Livestock Inspectors to detect the resulting infestations and prevent their spread more deeply into the U.S. Infested herds are dipped every 14 days for up to 9 months to eliminate the tick from the premises.

The area along the river is under permanent Federal and State quarantine to assist in containing the tick to a relatively small area along the Rio Grande. These procedures are inadequate. Presently the tick has spread beyond the quarantined area. A large number of herds in the so-called "free" area have been found to be infested and there is reason to believe that additional herds are also infested. There is no official and no effective surveillance outside the quarantined area thus providing the potential for an alarming number of unknown foci of infestations from which still further spread is possible.

Resolution

BE IT THEREFORE RESOLVED that the U.S.A.H.A. strongly urge the U.S. Secretary of Agriculture to declare that an emergency exists in regard to cattle fever tick which not only threatens Texas but many other states.
Resolution No. 25

Held at: Miami Beach, Florida

Source: Ad Hoc Epizootic Attack Plans

Subject Matter: Review regulations

BACKGROUND INFORMATION

There is increasing proof of diseased birds being smuggled into the United States and there may be a conflict between regulations and policies of the United States Department of Agriculture and United States Department of Interior relative to confiscation and destruction of avian and mammalian species seized during attempted illegal entry into the United States.

RESOLUTION

BE IT RESOLVED that the United States Animal Health Association urge the U. S. Secretary of Agriculture and the U. S. Secretary of Interior to review their regulations and policies pertaining to importation of avian and mammalian species and authority to destroy avian and mammalian species seized during attempted illegal entry into the United States, so the court will not find conflicting regulations and policies, and can hastily act to prevent introduction of velogenic viscerotropic Newcastle Disease, Fowl Plague and other devastating exotic diseases of poultry and livestock.
BACKGROUND INFORMATION

WHEREAS, during the latter part of the 19th Century, a mysterious malady was imposing staggering financial losses, which at that time were estimated at 40 million dollars annually to cattlemen of the mid-west;

WHEREAS, since this insidious sickness became conspicuous when Texas cattle were driven to the great railheads of the West and coincided with death of countless thousands of northern cattle, the entity became known as Texas Cattle Fever;

WHEREAS, in 1887 it was recognized that previously contaminated pens, barns, and pastures were dangerous during the warmer months, but from the first heavy autumn frost through the last severe spring frost, this disease was rare;

WHEREAS, in 1893, a protozoan (Babesia bigemina) and a one-host tick (Boophilus annulatus) were concomitantly incriminated as factors causing this costly disease, whereby the arthropod vectors were referred to as Texas Cattle Fever Ticks;

WHEREAS, by the early 1900s fever ticks had become spread throughout most southern states, which posed an ominous threat to the livestock economy of this region as carriers of the deadly cattle disease, piroplasmosis;

WHEREAS, dipping was deemed to be a feasible approach for conducting a national cattle fever tick eradication program, in 1906 the mammoth project was inaugurated by the Bureau of Animal Industry of the U.S. Department of Agriculture;

WHEREAS, after expenditure of millions of dollars, fever tick eradication was successful until 1931, when "breaks" occurred in Florida where white-tailed deer were incriminated as hosts for B. microplus, the tropical counterpart of B. annulatus;

WHEREAS, as a consequence of these findings over twenty thousand wild deer were annihilated as part of the national fever tick eradication effort resulting in tremendous loss of that resource in the State of Florida;

WHEREAS, at present all states are free of fever ticks with exception of Texas, where both B. annulatus and B. microplus are entrenched in the southern portion of that state and threaten to break out of the quarantine zone; and

WHEREAS, cattlemen of Texas are sharing the brunt of burden and responsibility in combating this threat to a significant segment of the livestock and big game animal resources of the United States at a tremendous expense to many individual ranchers.

RESOLUTION

NOW, THEREFORE, BE IT RESOLVED, that the United States Animal Health Association (USAHA) urge the Secretary of Agriculture to consider fever tick eradication in Texas as a national problem for which there is no assurance that this devastating disease potential will remain within said state.
BE IT FURTHER RESOLVED, that members of this body (USAHA) support the Secretary of Agriculture in procurement of essential funding through Congress for eradicating fever ticks from Texas to prevent spread into other vulnerable states with subsequent jeopardy to this nation's livestock and big game animal resources.
Resolution No. 27

Held at: Miami Beach, Florida

Source: Infectious Diseases of Cattle

Subject Matter: Bovine Semen

BACKGROUND INFORMATION

Many private distributors of bovine semen may custom freeze and sell semen for bulls without regard to the health status of the bulls. Semen has been collected by custom processors and sold from bulls rejected by commercial Artificial Insemination Organizations, because health examinations indicated they were positive to one or more of the following diseases: Virbiosis, Leptospirosis, Brucellosis, Trichomoniasis and Tuberculosis. Transmittal of any of the aforementioned diseases could destroy or inflict serious economic loss upon entire herds of dairy cattle. A resolution calling for the American Dairy Science Association to work with the U.S. Department of Agriculture and National Association of Animal Breeders to develop health standards for bulls producing semen for distribution, and thereby protect purchasers of bovine semen, was passed by the American Dairy Science Association Extension Section, and presented at the U.S. Animal Health Association meeting in 1968. A United States Animal Health Association subcommittee of the committee on Infectious Diseases of Cattle was appointed in 1968 to work with the USDA's Animal and Plant Health Inspection Service to study this matter. The U.S. Animal Health Association, in 1969 approved committee action to provide the USDA with a statement of minimum health standards for bulls used in artificial insemination as a basis for development of appropriate regulations. The initial proposed regulations were published in the Federal Register in 1971, and the American Association of Veterinary Laboratory Diagnosticians prepared a handbook of procedures in 1972 for tests required by a revised version of these regulations. The sire health committee and Board of Directors of the National Association of Animal Breeders strongly support such regulations. The Animal and Plant Health Inspection Service agreed in 1975 to publish proposed revised rules in the Federal Register at a time when they appear to have widespread industry support.

RESOLUTION

BE IT RESOLVED that the U.S. Animal Health Association call upon the Animal and Plant Health Inspection Service to immediately publish in the Federal Register, revised proposed regulations governing interstate movement of bovine semen and, after due process, implement these regulations.
Mr. Chairman:

The Committee on Livestock Commerce met as scheduled with 12 members and guests in attendance.

Concern was expressed about industry apathy regarding the testing of horses for equine infectious anemia, especially in areas where it is known the incident rate is low. The disease control benefits versus restraint of commerce was considered. The Committee agreed this matter should be presented to the U. S. Animal Health Association Committee on Infectious Diseases of Horses for its consideration and evaluation relative to current EIA testing recommendations.

During the discussion of the EIA testing program, a problem concerning laboratory reporting of EIA positive samples back to regulatory officials of the State of origin when samples are processed from another state was considered. The Committee agreed this matter should also be referred to the Infectious Diseases of Horses Committee for its consideration and any necessary action.

A motion was passed to refer to the U.S.A.H.A. Nationwide Eradication of Hog Cholera Committee an industry problem concerning what is felt to be unnecessary paper work and expense for permit requirements now that hog cholera has practically been eradicated from the United States. Again this is a deterrent to commerce if that be the case.

In discussing last year's recommendation that the Committee be kept informed of any prospective legislative proposals concerning the humane handling of livestock in commerce, it was unanimously agreed that the Committee Chairman should contact and request that the Chairman of the USAHA Animal Welfare Committee allow the Commerce Committee an opportunity for input prior to final recommendations if an item comes up in that committee's deliberations that would also directly affect livestock commerce.

Areas of the livestock commerce committee's responsibilities were discussed. Numerous actions are taken by many USAHA committees which often can adversely affect livestock commerce. Defining these
problem areas and working out solutions on behalf of the livestock industry is a primary goal. Efforts to do this must be exerted within the USAHA committees, state and federal governments, and within the livestock industry itself. It is requested that the Executive Board of the USAHA clarify the areas of responsibility of the Livestock Commerce Committee to thus assure maximum committee performance.

This constitutes the report of the Livestock Commerce Committee.

I respectfully submit the report for approval by the Executive Committee.

L. N. Butler
Co-Chairman
REPORT OF THE COMMITTEE ON
WILD AND MARINE LIFE DISEASES

Chairman: Dr. Frank A. Hayes, Athens, GA
Donald E. Cooperrider, Joe B. Finley, Jr., Harry G. Geyer, Andrew H. Hulsey, Benjamin S. Pomeroy, Robert E. Putz, James S. Smith

This committee was called to order at 1:30 PM, November 10, 1976, with the members above in attendance.

Numerous distinguished guests also were welcomed for this occasion and urged to participate in all discussions that ensued.

The first item on the agenda was a report from Dr. Geyer on Developments between the Extension Service of the U. S. Department of Agriculture (USDA) and the International Association of Fish and Wildlife Agencies (IAFWA) for establishment of better liaison between agriculture and conservation interests of the United States. Reference was made to a previous presentation by Dr. Jack H. Berryman, Chief, Division of Technical Assistance, U. S. Fish and Wildlife Service of the United States Department of Interior (USDI), which related to the increasing desirability for better rapport between the Extension Service and those agencies responsible for this nation's wildlife interests. It was pointed out that Dr. Berryman's proposal was well received during the Annual Meeting of IAFWA on September 22, 1976, at Dearborn, Michigan. It is hopeful that this will be the beginning of meaningful relations to serve in the best interest of our national welfare.

The next two items on the agenda also were addressed by Dr. Geyer, which consisted of status reports on the Wild Horse Act and Blackbird Control Bill. A need thereby was recognized by the committee for better working relationships between this nation's wildlife and domestic livestock interests. It was mutually agreed by committee members that such should be pursued.

Next on the agenda was a presentation by Dr. T. Lynwood Barber, Supervisory Veterinary Medical Officer of the Anthropod-Borne Animal Disease Research Laboratory, Agricultural Research Service, USDA, Denver, Colorado. Dr. Barber's excellent report on the serotypes of bluetongue and epizootic hemorrhagic disease viruses in wildlife was followed by a lively discussion relating to the need for more information on these emerging disease entities and their implications for domestic and wild animals. A resolution thereby evolved from these deliberations, which hopefully will be adopted by USAHA.

In addition, two other disease oriented resolutions originated from this committee. These relate to the increased threat of foot-and-mouth
disease (FMD) introduction onto the North American Continent as a consequence of completing construction on the Darien Gap Highway and the current cattle fever tick situation in Texas as such jeopardizes the welfare of this nation's domestic livestock economy. Hopefully, these resolutions also will be adopted by USAHA.

In conclusion of the meeting of the Committee on Wild and Marine Life Diseases, both members and guests recognized a need for development of a broad memorandum of understanding between all state and federal agencies that may become involved in the event of foreign animal disease introduction. All parties concerned subsequently are urged by this committee to finalize necessary arrangements to serve mutual interests before the next national disease emergency occurs.

Respectfully submitted, November 11, 1976.

Frank A. Hayes, Chairman
USAHA Committee on Wild and Marine Life Diseases
REPORT OF THE COMMITTEE ON PARASITIC DISEASES AND PARSITICIDES

Chairman: J. L. Hourrigan, Hyattsville, MD
Co-Chairman: R. L. Pyles, Albuquerque, NM


Your committee met in open session on Monday, November 8 and discussed the following:

Internal Parasites

Dr. G. E. Reynolds (Extension Veterinarian) presented the results of a survey conducted in Oregon to evaluate the Economic Importance of the Common Liver Fluke Fasciola hepatica. Co-Authors of the paper were T. P. Kistner (Veterinary Parasitologist) and S. C. Marks (Extension Agricultural Economist) all from Oregon State University, Corvallis, Oregon.

The estimated mean incidence of flukes was 44.9% for cattle and 40% for sheep. Estimates (mean) of direct mortality from liver flukes were 0.4% for cattle and 0.8% for sheep. Estimated mortality due to Clostridium novyi and C. hemolyticum, secondary to fluke infections were 1.1% for cattle and 0.8% for sheep.

Estimated annual losses in Oregon beef cattle caused by liver flukes, (1975 animal numbers and values) were:

<table>
<thead>
<tr>
<th>Infection Rate</th>
<th>Maximum</th>
<th>Minimum</th>
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<tr>
<td>No. Infected</td>
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<td>Value</td>
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<td>Direct Mortality (0.4%)</td>
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<td>$179,200</td>
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<td>Clostridial Losses (1.1%)</td>
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<td>Production Losses (7.7%)</td>
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<td>Liver Condemn. (17.5%)</td>
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<td>(400,000/yr.; $4.00/liver)</td>
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<tr>
<td>Vaccination Costs, $1.0/head/yr. (50%)</td>
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Dr. Kendall G. Powers, Bureau of Veterinary Medicine, Division of Veterinary Research, Food and Drug Administration (FDA) discussed anthelmintics developed since 1961 and FDA regulations and guidelines for testing, evaluating, and FDA approval of new animal drugs. The text of his paper will be part of your committee report.
During the past 15 years there has been considerable progress by pharmaceutical companies in developing and marketing a series of new, broad spectrum anthelmintics for use by the agricultural industry in this country. In the early 1960's, thiabendazole, which has a wide range of antiparasitic action, a high degree of efficacy and a good margin of safety, became available for use in domestic animals and introduced what has been referred to as an era of modern anthelmintics. About 10 years later two other benzimidazole derivatives (mebendazole and cambendazole) were approved for marketing. Also during the past 15 years we have seen a number of organophosphates (trichlorfon, dichlorvos and haloxon), imidazole derivatives (levamisole HCl and levamisole PO₄), and pyrimidine derivatives (pyrantel pamoate and pyrantel tartrate) gain a place in treating a broad spectrum of parasites in various animal species. Although considerable progress has been made in many areas of veterinary parasite chemotherapy there still are several areas of economic need for new, effective anthelmintics. For example, the swine industry urgently needs a drug for kidney worms (Stephanurus dentatus) and the cattle and sheep industries do not have an approved anthelmintic for liver flukes (Fasciola hepatica). Several different compounds are currently being evaluated in these areas and we are optimistic that some of these will have adequate safety and efficacy when used against one or both of these parasites.

There is a continuing need to identify new anthelmintics and a primary mission of the Bureau of Veterinary Medicine is to determine that any new animal drug submitted for approval is safe and effective for use as suggested in the proposed label. Safety considerations require that the product, when used as directed, must: 1) be safe for the target animal and 2) not produce hazardous residues of the drug or its metabolites in edible tissues derived from food producing animals to which it is administered. An additional consideration related to safety is a determination of the effect the usage of this drug may have on the environment.

Efficacy considerations are primarily based upon substantial evidence that adequate and well controlled investigations, including field studies, were performed using the proposed dosage form of the drug. Three types of controlled comparisons are used in evaluating the efficacy of a new drug: (1) placebo control—comparison with a placebo, (2) active drug control—compared quantitatively with another drug or modality known to be effective or (3) historical con-
control—in diseases with high and predictable mortality or with signs and symptoms of predictable duration or severity the results of a new animal drug may be compared quantitatively with prior experience historically derived. Uncontrolled or partially controlled studies are not acceptable as the sole basis for the approval of claims of effectiveness. Isolated case reports, random experience and reports lacking the details which permit scientific evaluation will not be considered. In addition to one of the three controlled investigations, it is essential that the product be carefully evaluated in the field under anticipated conditions of use.

Parasitologists routinely use three methods for evaluating the efficacy of anthelmintics. The controlled test contains comparable groups of animals that are either medicated or retained as unmedicated controls. At necropsy, worm burdens in treated and untreated animals are compared and efficacy computed. The critical test utilizes the animal as its own control. Total feces are collected each day for a period of time after therapy and worms passed in the feces are compared with worms remaining in the animal at necropsy. The critical-controlled test combines the critical and the controlled test and efficacy is determined by both methods.

Proposed guidelines are currently being prepared to help investigators design anthelmintic studies that will generate adequate efficacy data for the approval of new animal drugs. Whenever possible recommendations and ideas for these guidelines will be solicited from expert parasitologists from academia, government and industrial laboratories. It is desirable that prior to formalizing a guideline for a particular group of animal species, i.e. equine, ruminant, canine or swine, an expert panel will be convened and the proposed guideline discussed. Such a panel is meeting in open session in Chicago in November 1976 to formulate a guideline for the evaluation of equine anthelmintics. Among the major issues that are expected to be resolved are the usefulness of the critical test in anthelmintic evaluations, the minimum number of animals per trial, the minimum number of worms per animal for each claimed species and the minimum number of controlled investigations and clinical field trials, in different geographic areas, necessary to adequately evaluate an anthelmintic. The question of what constitutes an acceptable percent efficacy for a candidate drug, against each claimed species, also will be discussed.

Additional data with particular reference to the problem of flukes in Texas, was presented by Dr. R. R. Bell, Professor and Head, Department of Veterinary Parasitology, Texas A&M University.

Dr. Homer R. Smith, Regional Veterinary Medical Officer (Region V) FDA, Cincinnati, Ohio discussed the status of parasiticides under the Federal Food Drug and Cosmetic Act and the areas of responsibility of FDA and the Environmental protection Agency (EPA).
REPORT OF THE COMMITTEE

The Food and Drug Administration is assuming complete authority for regulation of new animal drugs containing pesticides. The Agency had shared responsibility for these products with EPA.

In the future new animal drugs, that would have been subject to both registration requirements of EPA and FDA's drug process, will be subject only to FDA approval and regulation as new animal drugs.

The Commissioner of FDA has asked all holders of approved New Animal Drug Applications (NADA) for products that are also the subject of EPA registration, to voluntarily identify their products in writing to the Bureau of Veterinary Medicine, FDA. The deadline for voluntary action was August 30, 1976.

Ectoparasites

Dr. Harry W. Kinne, District Veterinarian, VS, APHIS, USDA, Laredo, Texas, discussed problems in regard to the Cattle Fever Tick Eradication Program and means for overcoming these problems. A plan was developed to eliminate the tick from an area on a large ranch in South Texas where the eradication has been particularly difficult, for evaluating the role of deer as hosts for the tick and for considerably broadening the surveillance activities in the quarantined area along the Rio Grande River and also in the area extending north in Texas to Highway 90.

Dr. James E. Christy, Scabies Epidemiologist, VS, APHIS, USDA, Amarillo, Texas, discussed the cattle scabies problem and need to find the sources of outbreaks sooner and more effectively. The committee felt that more effort should be put into both the scabies and the tick activities and that this will take more money and manpower. Resolutions to this effect were forwarded to the executive committee.

CATTLE FEVER Ticks

General

During FY 1976 (through June 30, 1976) Boophilus sp. ticks were collected from 51 herds of 306 native livestock located within the area under State and Federal quarantine along the Rio Grande River in southern Texas, and from 84 herds of 1,990 livestock north of this quarantined area. In addition to these infestations, 149 cattle and 54 horses, smuggled or strayed from Mexico, were apprehended in the quarantined area—41 of the cattle and none of the horses were infested with Boophilus ticks; 13 lots of 27 tick-infested Mexico cattle were found in the quarantined area and 1 lot of 14 infested cattle north of this area.

None of 173 United States-owned livestock straying or being smuggled into Mexico and returned were infested.

A total of 22,399 certificates were issued involving the inspection and intrastate movement of 159,886 livestock. No certificates involved the interstate movement of livestock.
During FY 1976, 44 alleged illegal movements and smuggling were reported, with 24 defendants fined by year's end.

In the quarantined area 476,549 cattle and 30,973 horses or mules and outside the quarantined area in Texas 1,593,330 cattle and 39,760 horses or mules were inspected for ticks.

In the quarantined area, 83,442 cattle were treated (79,713 dipped and 3,729 sprayed) and 19,990 horses or mules were treated (1,488 dipped and 18,502 sprayed). Outside the quarantined area, 197,817 cattle were treated (169,033 dipped and 28,784 sprayed) and 28,794 horses were treated (1,187 dipped and 27,607 sprayed).

Delnav® was used to spray 46,109 horses or mules but was not used on cattle. Co-Ral® was used to treat 281,259 cattle and 2,675 horses or mules. Neither arsenic nor toxaphene were used. The Environmental Protection Agency has canceled the registration for arsenical cattle dip. Arsenic had been a permitted dip since 1911.

Permitted pesticides for official use against ticks are: 1) coumataphos (Co-Ral®) 25 percent wettable powder, 2) dioxathion (Delnav®) emulsions Del-Tox and Delnav-Extra, and 3) toxaphene emulsions Cooper-Tox Livestock and Lintox-X Livestock Spray and Dip.

In the quarantined area, of 56 infested herds 2 were found by pasture inspection, 14 by apprehension and inspection of strays, 2 were reported by the owner or manager, 26 during dipping and/or inspection prior to movement, 4 through tracing movements from infested or exposed herds, 1 during inspection of an adjacent herd, and 7 by special inspection. The source for 14 of the outbreaks was believed to have been stray Mexico cattle. The source for the remaining 42 infestations was not determined.

In the area outside the quarantined area, of 63 infested herds 1 was found by pasture inspection, 3 were reported by the owner or manager, 15 by dipping and inspection prior to movement, 6 through tracing from infested or exposed herds, 25 during special inspections, and 13 during inspection of adjacent herds. The source for the infestation was not determined for any of these 63 herds.

The general tick situation in Texas continued to give considerable concern. Additional outbreaks north of the permanent quarantine area, such as in Kleberg and Jim Wells Counties, have increased the workload and further weakened activities in the quarantine area as Federal and State inspectors must be detailed to the outbreaks more distant from the international border.

During the past decade, livestock production in south Texas has changed considerably with the cattle population doubling in many areas and more livestock markets and trading. This has been due to
several factors, including clearing brush and planting improved grasses, more watering tanks, and generally increased rainfall. This has greatly favored survival and spread of ticks.

Additional emphasis was placed on the role of wildlife, particularly white-tailed deer (*Odocoileus virginianus*). *Boophilus annulatus* were first recorded in the United States from collections taken from deer (Florida, 1821), and there have since been similar collections, including those made in Texas from time to time. Research clearly showed (Florida, 1933) that either *B. annulatus* or *B. microplus* could complete the life cycle on deer. This was further affirmed with *B. microplus* on St. Croix, U.S. Virgin Islands (1962 and 1966) and with *B. annulatus* near Laredo, Texas (1970). Deer populations had to be greatly reduced before *B. microplus* could be eradicated from Florida, and deer prevented the tick being eradicated from the U.S. Virgin Islands.

Until recently, there was little reason to believe deer played any significant role in tick eradication in Texas or to consider them in the program. However, there has been a tremendous increase in deer as well as cattle populations, and surveys now underway, although not yet completed, are revealing that deer may well require more consideration.

*Boophilus microplus* ticks were collected from deer in Kleberg County, Texas, in June and August 1976 and *B. annulatus* ticks were collected from deer in Webb County, Texas, in May, June, August, and September. *Boophilus* spp. ticks were collected from a deer hide in Zapata County in April 1976. In May, four *B. microplus* ticks were collected from a fresh deer hide found in Zapata County, Texas.

**Training**

A tick identification and eradication procedures training course was held at Beltsville, Maryland, October 15-18, 1975. Trainees included one State and nine Veterinary Services employees from Puerto Rico, New York, New Mexico, and Texas.

Immediately following (October 21-23) a pesticide application training course was held at Beltsville for the same trainees and, in addition, five Veterinary Services employees from Texas.

A “Tick Eradication Uniform Procedures Manual” was developed for use by the Tick Eradication Force in Texas. This will provide uniformity in application of program procedures. It is also being distributed to ranchers. This will provide an understanding of procedures and aid in securing their cooperation with the program.

A manual entitled “Ticks of Veterinary Importance” was developed by Veterinary Services at Beltsville and published as Agriculture Handbook 485.
Pesticidal Poisoning

In July, a Veterinary Services tick inspector was hospitalized with a diagnosis of pesticidal (Co-Ral®) poisoning, apparently due to overexposure while spraying cattle with a power spray. Efforts to lessen exposure will include greater attention in following safety recommendations, and in monitoring employees' cholinesterase levels and broader use of spray-dip machines, which are to be safety-modified as described in Veterinary Services Memorandum 556.5, in place of power sprayers.

Inspector Killed

In August, a Veterinary Services tick inspector was shot and killed while at one of the tick camps north of Laredo, Texas, along the Rio Grande River. His murderer has not been found.

In January 1975, an inspector was drowned accidentally in the Rio Grande River while roping a stray cow.

Puerto Rico

_Amblyomma variegatum_, the tropical bont tick, first reported from Puerto Rico during June 1974, has increased from the 26 premises reported in July 1974 to 59 premises as of September 1975 and 70 as of September 30, 1976. Although Veterinary Services of Animal and Plant Health Inspection Service, USDA, and the Commonwealth of Puerto Rico Department of Agriculture developed plans to eradicate this tick, it was not possible to implement the program due to lack of any funds or personnel ceiling for this purpose.

Surveys for Various Species of Ticks

Tick survey collections in CY 1975 included 4,542 as follows: From cattle—3,585; horses and mules—440; dogs—218; native wildlife—153; zoo animals and miscellaneous—94; and animals and products offered for importation—52.

Federal Quarantines

Effective July 22, 1975, Part 72, 9 Code of Federal Regulations was amended to exclude portions of Jim Wells, Kleberg, and Nueces Counties from Federal quarantine.

TICKS COLLECTED FROM ANIMALS OR MATERIALS BEING IMPORTED INTO THE UNITED STATES

megnini collected from zebra, tortoise, Big Horn sheep, hedgehog, inanimate object, horse, goat, cattle, iguana, human, deer trophy, and orchid.

*Haematopinus eurysternus, Linognathus vituli*, and *Bovicolo bovis* (cattle lice) were collected from cattle being imported from England.

**Research**

The U.S. Livestock Insects Laboratory (USDA-ARS) at Kerrville, Texas, has established a sublaboratory (Cattle Fever Tick Research Laboratory) at a 30-acre site on a peninsula just below Falcon Dam on the Rio Grande River near Falcon, Texas.

Activities in cooperation with the Texas Animal Health Commission (TAHC), Veterinary Services (USDA-APHIS), The Institute of Tropical Veterinary Medicine and the Department of Entomology (Texas A&M University) will include research on the concentration of insecticides in dipping vats, disease transmission by *Boophilus* sp., biology, ecology, and control of *Boophilus* sp. resistance to acaricides, survival off the host, and host relationships.

**CATTLE SCABIES**

**General**

Clearly, the psoroptic cattle scabies situation in the general Panhandle area, and particularly in Texas and New Mexico, is not encouraging.

For the decade prior to FY 1972, although the disease had not been completely eliminated, the number of reported infected herds averaged only five per year. There was a dramatic increase in number of infected herds found in 1972 when 91 were reported. This was followed by 53 infected herds in 1973, 39 in 1974, 49 in 1975, and 77 in 1976 through June 30. During July, August, and September 1976 there were 12 additional infected herds reported.

In an effort to bring the disease under control, several special regional meetings were held. These included a meeting in Denver, Colorado, in March 1972; a Scabies Research and Control Work Conference at Bushland, Texas, in August 1973; an *ad hoc* meeting of this committee, also in Denver in April 1975; and the most recent meeting, again in Denver, was held this past September 13.

These scabies meetings confirmed general agreement on what is needed to proceed successfully against the mites, and it seemed that surely history should repeat itself, that the cattle scabies situation would improve and that the overall outbreak would come under control and the number of outbreaks would quickly return to the previous low number. Such was not to be, and the number of infected herds has remained essentially the same. Moreover, the disease is being found distant from the general Texas Panhandle area; for
example, infected herds in southwest Texas, south and west New Mexico, Arizona, California, and into the Southeast in Georgia.

There is little reason to believe the psoroptic mite has developed resistance to the pesticides we use, or that the susceptibility of cattle has changed. We have excellent permitted dips which will, if properly used, eradicate the mite from an infected animal; and if the eradication program is properly funded, a sufficient number of personnel are assigned, trained, motivated, and directed, and if the overall effort is properly organized, eradication can be achieved from an area, county, State, or the entire country.

In a disease eradication program, as in battle, the situation will not long remain static. Either one adversary or the other achieves sufficient strength, momentum, and "will" to overcome the other.

Evidently, we have not brought sufficient strength to bear against the mite or we have not properly organized or utilized the strength and resources available to us.

The 89 outbreaks reported during FY 1976 were reported from 10 States as follows:

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<td>34</td>
<td>30</td>
<td>4</td>
</tr>
<tr>
<td>Texas</td>
<td>16</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>89</td>
<td>77</td>
<td>12</td>
</tr>
</tbody>
</table>

Outbreaks reported by month were July 1975—0, August—1, September—5, October—4, November—8, December—17, and January 1976—4, February—16, March—16, April—5, May—0, and June—1; a subtotal of 77 for the traditional (July 1-June 30) fiscal year. During the additional 3 months, there were 12 additional outbreaks making a total of 89 for the changed FY 1976: July 1976—3 outbreaks, August—3, and September—6.

The 89 outbreaks were divided nearly equally between feedlots (45 outbreaks) and ranch or range operations (44 outbreaks). Feedlots included preconditioning lots, lots with "futures" cattle, and finishing lots.
FY 1976 cattle scabies activities compared to recent previous years as follows:

<table>
<thead>
<tr>
<th>Fiscal year</th>
<th>Infected herds</th>
<th>Infected States</th>
<th>Counting Field</th>
<th>Public stockyards Field</th>
<th>Public stockyards</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>28,670,897</td>
<td>15,632,899</td>
</tr>
<tr>
<td>1971</td>
<td>11</td>
<td>3</td>
<td>7</td>
<td>25,321,574</td>
<td>14,019,291</td>
</tr>
<tr>
<td>1972</td>
<td>91</td>
<td>7</td>
<td>47</td>
<td>36,231,843</td>
<td>12,233,311</td>
</tr>
<tr>
<td>1973</td>
<td>53</td>
<td>8</td>
<td>33</td>
<td>39,181,970</td>
<td>None</td>
</tr>
<tr>
<td>1974</td>
<td>39</td>
<td>9</td>
<td>33</td>
<td>25,749,166</td>
<td>&quot;</td>
</tr>
<tr>
<td>1975</td>
<td>49</td>
<td>7</td>
<td>30</td>
<td>17,610,952</td>
<td>&quot;</td>
</tr>
<tr>
<td>1976*</td>
<td>77</td>
<td>10</td>
<td>40</td>
<td>25,716,711</td>
<td>&quot;</td>
</tr>
<tr>
<td>1976**</td>
<td>12</td>
<td>6</td>
<td>10</td>
<td>&quot;</td>
<td>9,697,005</td>
</tr>
</tbody>
</table>

*Thru June 30
**July, August, and September 1976

Scabies Epidemiologist Assigned

A veterinary epidemiologist was assigned to the scabies program to develop a picture of scabies as it affects the cattle industry in the United States to aid the various States in carrying out uniform eradication procedures. This will provide a study of new marketing and feeding patterns. The development of preconditioning lots, sales of futures, contract feeding, and continuous high-energy rations are all important to the total picture of scabies and scabies eradication. He is stationed at Amarillo, Texas.

During FY 1976, recommended procedures were developed and accepted by the USAHA for treatment and handling of psoroptic cattle scabies. This is the first successful development of such a procedure. It will provide the agencies and the industry a guide for the program.

Training

A scabies eradication course at Albuquerque, New Mexico, November 12-15, 1975, provided training for 14 Veterinary Services and 1 State employee from Oklahoma, Texas, Colorado, and Kansas.

Nine of the trainees also participated in a Pesticide Use Training Course, November 18-19.

Collection of other Mites

Activities in regard to chorioptic mites were reduced with only 22 identifications reported from cattle by the Veterinary Services Laboratory at Beltsville, Maryland, as follows: Texas—14, Arizona—2, and 1 each from Illinois, Iowa, Louisiana, Missouri, Nebraska, and Pennsylvania.

Chorioptic mites were collected from a horse in Wisconsin.
Sarcoptic mites were collected from seven cattle herds in Vermont.
Psoroptic mites were collected from the ears of a thoroughbred gelding in Maryland.

Federal Regulations

Part 73, 9 Code of Federal Regulations was amended effective February 6, 1976, so that either State or Veterinary Services inspectors may supervise dipping of scabies-affected or -exposed cattle, limited interstate movement following negative inspection to 10 days and provided cattle of similar status may move interstate from either federally quarantined or nonquarantined areas under similar restriction. Effective January 23, 1976, owners were required to waive all claims against the Federal Government when their cattle are treated for scabies; and Part 73 was amended many times to conform to the policy that Federal quarantines be placed on minimum geographic areas when cattle scabies was diagnosed and removed promptly when the infestation was eliminated.

Permitted Dips for use against Scabies Mites

Effective August 27, 1976, the concentration of Prolate® (Starbar GS-118) (first listed as a permitted dip September 11, 1975) was lowered from 0.20-0.25 percent to 0.15-0.25 percent. This was done after review of research efficacy data and Environmental Protection Agency (EPA) label requirements. Dipped animals should be withheld from slaughter for 21 days. Although a field test has been developed to determine bath concentrations of Prolate®, regulatory officials have not yet evaluated the test.

Other permitted dips are toxaphene emulsion (Copper-Tox Livestock and Lintox-X-Livestock spray and dip) and coumaphos (Corral®) 25 percent wettable powder and lime-sulfur solution.

On one occasion it was noted that damage to 50 gallon steel drums had resulted in fracture of the required interior baked phenolic resin liner. This exposed the contents (toxaphene emulsion) to the raw steel drum which catalyzes degradation of the emulsifiers. Pesticides from damaged containers should not be used.

One toxaphene emulsion was observed in the field to have a label specifying “Permitted for Use in Official Dipping.” However, the product was not a permitted dip and did not meet emulsion stability requirements.

Vat Management

The Texas Agriculture Extension Service sponsored an Extension Field Day—“Dip Vat Management Systems for Cattle Feedyards.” Although some vats are well managed, laboratory quantitative analysis results reveal that some vats need better management.
Laboratory confirmed SW cases were reported as follows:

<table>
<thead>
<tr>
<th>State</th>
<th>CY 1975</th>
<th>CY 1974</th>
<th>CY 1973</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>557</td>
<td>197</td>
<td>4,714</td>
</tr>
<tr>
<td>Arkansas</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>California</td>
<td>1</td>
<td>48</td>
<td>235</td>
</tr>
<tr>
<td>Colorado</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Iowa</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Louisiana</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Nevada</td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>New Mexico</td>
<td>266</td>
<td>99</td>
<td>1,103</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>14</td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td>Texas</td>
<td>16,723</td>
<td>6,900</td>
<td>8,913</td>
</tr>
<tr>
<td>Utah</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>17,561</td>
<td>7,267</td>
<td>14,976</td>
</tr>
</tbody>
</table>

During calendar year 1976 (January 1-October 2, 1976) there were 20,514 confirmed SW cases in the continental United States: Texas—20,258; New Mexico—64; Arizona—137; California—0; Oklahoma—53; and Arkansas—2. There were 11,394 SW cases reported in Mexico within the barrier zone and 12,564 SW cases south of this barrier. During this period, the Mission, Texas, plant produced nearly 10 billion sterile SW flies with more than 5 billion distributed in the United States and more than 4 billion distributed in northern Mexico.

A new strain of fly was introduced into production in mid-March 1976 and proved to be larger and superior to previous strains produced, according to a battery of tests and performance evaluations. With this strain of sterile fly, the program was successful in keeping infestations in New Mexico, Arizona, and California to a minimum. However, the program was not able to prevent the large number of cases which occurred in Texas, where the native fly population was assisted by continued favorable weather and the usual seasonal build-up of Gulf Coast ticks, Amblyomma maculatum.

Other factors favoring the wild SW fly includes 100 percent increase in cattle populations in south Texas, an even greater increase in deer populations, a change in livestock management practices with fewer cowboys, and calving and dehorning, castrating, etc., occurring the year round.

Although the number of cases in Texas up to April 1976 were comparable to those for the same period in 1972, the number of cases reported after April in 1976 rose less dramatically than in 1972, suggesting the new strain of sterile fly had a beneficial effect in holding down the number of screwworms.
The three-host Gulf Coast tick infests a large number of hosts and is extending into south central and east Texas and as far north as Oklahoma. About 90 percent of the SW cases are found in ear wounds caused by the ticks during July, August, and September, when tick infestations are greatest. Field tests using Rabon® or Dursban® insecticide-impregnated ear tags or ear bands greatly reduced tick infestations of test cattle, and no SW cases were found in the ears of treated test cattle. Whether this method of control will be sufficiently available and utilized widely enough by cattlemen remains to be seen.

After considerable study and evaluation, the U.S. Department of Agriculture concluded that the SW Eradication Data System, as developed by the National Aeronautics and Space Administration, was not sufficiently useful to be incorporated into the eradication program.

Effective August 3, 1976, Federal Regulations (CFR, Part 83, Title 9) were amended to designate the remainder of the State of Texas as an area of recurring SW infestation.

The most encouraging development in the SW program is the completion of the Joint U.S.-Mexico SW sterile fly production plant in southern Mexico at Tuxtla Gutierrez.

Construction of the 18,000 square meter plant—and supporting buildings such as the administration building, warehouse and motor pool—began in July 1973 and was essentially completed by July 1976. The estimated cost of the totally equipped facility is $14 million, exclusive of the site, which was donated by the Governor of the Mexican State of Chiapas to the Mexico Secretariat of Agriculture and Livestock (SAG) for use by the Joint Commission.

The huge new facility has a capacity to produce over 300 million sterile SW flies per week and will employ over 500 workers, plus a small complement of U.S. and Mexican supervisors. Currently, there are more than 20 VS employees and their families living in Tuxtla Gutierrez. The entire program, with U.S. and Mexico employees scattered throughout Mexico, will number over 75 Americans and an equal number of Mexican government counterparts, plus 1,300 Joint Commission employees.

The immediate goal of the program is to eradicate screwworms from Baja California and northern Mexico. Then sterile flies from both the Tuxtla Gutierrez plant and the Mission, Texas, plant will be used to push the present 2,000 mile-long SW barrier between the two countries to a 125 mile-wide barrier zone across the Isthmus of Tehuantepec in southern Mexico. The current barrier costs $15.5 million annually to maintain. The new barrier zone will cost an estimated $1.8 million annually, and will eliminate SW losses in the United States and most of Mexico.

General distribution of sterile flies from the Tuxtla plant began the week ending September 4, when 2½ million sterile flies were air-lifted to Baja California and distributed there.
TABLE OF ANTHELMINTICS MARKETED IN THE UNITED STATES

Kendall G. Powers, PhD, and Henry C. Hewitt, DVM

Arsenamide sodium—AR
Butonate—BU
n-Butyl Chloride—NBC
Cambendazole—CAM
Coumaphos—COU
Crufomate—CRU
Dichlorophene & toluene—DT
Dichlorvos—DI
Diethylcarbamazine—DEC
Diethylcarbamazine citrate—Dec-C
Diethylcarbamazine & styryl-pyridinium chloride—DEC-S
Disphenol—DIS
Dithiazanine iodide—DTI
Haloxon—HAL
Hygromycin B—HYG
Levamisole HC1-LH
Levamisole HCl & piperazine dihydrochloride—LP
Levamisole phosphate—LPH
Mebendazole—MB
Piperazine adipate—PA
Piperazine-carbon disulfide complex with phenothiazine—PCP
Piperazine citrate—PC
Pyrantel pamoate—PP
Pyrantel tartrate—PT
Thiabendazole—TBZ
Thiabendazole & piperazine citrate—TBZ-P
Thiabendazole & trichlorfon—TBZ-T
Ticarbodine—TI
Trichlorfon—TR

The above does not contain all legally marketed anthelmintics. It does, however, include all those drugs that will be discussed during the presentation and have been codified in the Code of Federal Regulations, Food and Drugs, Part 500 to 599: 21, 1976.

**Listed parasites are not all inclusive and generally represent those species more commonly found in cattle, sheep, swine, equines or dogs.
## Parasitic Diseases and Parasiticides

### Cattle

<table>
<thead>
<tr>
<th>Name of parasite**</th>
<th>Common name</th>
<th>Therapy*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemonchus placei</td>
<td>large stomach worm</td>
<td>COU, CRU, HAL, LH, LPH, TBZ</td>
</tr>
<tr>
<td>Ostertagia ostertagi</td>
<td>med. stomach worm</td>
<td>COU, CRU, HAL, LH, LPH, TBZ</td>
</tr>
<tr>
<td>Trichostrongylus axei</td>
<td>hairworm</td>
<td>COU, CRU, HAL, LH, LPH, TBZ</td>
</tr>
</tbody>
</table>

### Abomasum (nematode)

| Trichostrongylus colubriformis | hairworm                  | COU, CRU, HAL, LH, LPH, TBZ |
| Bunostomum phlebotomum         | hookworm                  | LH, LPH                    |
| Cooperia sp.                   | cooperia                  | COU, CRU, HAL, LH, LPH, TBZ |
| Strongyloides papillosus       | threadworm                | COU, CRU, LH, LPH, TBZ     |
| Nematodirus helvetianus         | thread-necked worm        | COU, CRU, LH, LPH, TBZ     |

### Small Intestine (nematodes)

| Monezia benedeni              | common tapeworm           |
| M. expansa                    | common tapeworm           |

### Large Intestine (nematodes)

| Trichuris ovis                | whipworm                  |
| Oesophagostomum radiatum      | nodular worm              |

### Lungs (nematode)

| Dictyocaulus viviparus        | lungworm                  |

### Liver (trematodes)

| Fasciola hepatica             | common liver fluke        |
| Fascioloides magna            | large american fluke      |
## SHEEP

<table>
<thead>
<tr>
<th>Name of parasite**</th>
<th>Common name</th>
<th>Therapy*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ABOMASUM</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(nematodes)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Haemonchus contortus</em></td>
<td>large stomach worm</td>
<td>CRU, HAL, LH, TBZ</td>
</tr>
<tr>
<td><em>Ostertagia</em></td>
<td>med. stomach worm</td>
<td>CRU, HAL, LH, TBZ</td>
</tr>
<tr>
<td><em>circumcincta</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Trichostrongylus axei</em></td>
<td>hairworm</td>
<td>CRU, LH, TBZ</td>
</tr>
<tr>
<td><strong>SMALL INTESTINE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(nematodes)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Cooperia curticei</em></td>
<td>cooperia</td>
<td>CRU, HAL, LH, TBZ</td>
</tr>
<tr>
<td><em>Strongyloides</em></td>
<td>threadworm</td>
<td>CRU, TBZ</td>
</tr>
<tr>
<td><em>papillosus</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Trichostrongylus</em></td>
<td>hairworm</td>
<td>CRU, LH, TBZ</td>
</tr>
<tr>
<td><em>colubriformis</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Nematodirus spathiger</em></td>
<td>threadnecked worm</td>
<td>LH, TBZ</td>
</tr>
<tr>
<td><em>Bunostomum</em></td>
<td>hookworm</td>
<td>LH, TBZ</td>
</tr>
<tr>
<td><em>trigonoccephalum</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(cestodes)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Monesia expansa</em></td>
<td>common tapeworm</td>
<td></td>
</tr>
<tr>
<td><em>Thysanosoma</em></td>
<td>fringed tapeworm</td>
<td></td>
</tr>
<tr>
<td><em>actinioides</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LARGE INTESTINE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(nematodes)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Trichurus ovis</em></td>
<td>whipworms</td>
<td>CRU</td>
</tr>
<tr>
<td><em>Oesophagostomum</em></td>
<td>nodular worm</td>
<td>LH, TBZ</td>
</tr>
<tr>
<td><em>columbianum</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Chabertia ovina</em></td>
<td>large mouth</td>
<td>LH, TBZ</td>
</tr>
<tr>
<td><em>bowel worm</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LIVER</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(trematodes)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Fasciola hepatica</em></td>
<td>common liver fluke</td>
<td></td>
</tr>
<tr>
<td><em>Fascioloides magna</em></td>
<td>large american liver fluke</td>
<td></td>
</tr>
<tr>
<td><strong>LUNGS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(nematodes)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Dictyocaulus filaria</em></td>
<td>thread lungworm</td>
<td>LH</td>
</tr>
<tr>
<td><em>Muellerius capillaris</em></td>
<td>hair lingworm</td>
<td></td>
</tr>
</tbody>
</table>
## SWINE

<table>
<thead>
<tr>
<th>Name of parasite**</th>
<th>Common name</th>
</tr>
</thead>
</table>
| **STOMACH**  
(nematodes) |                                  |
| Ascarops *strongylina* | thick stomach worm  DI |
| *Hyostrongylus rubidus* | red stomach worm                |
| **SMALL INTESTINE**  
(nematodes) |                                  |
| *Strongyloides ransomi* | threadworm                       LH, TBZ |
| *Ascaris suum* | large roundworm                   DI, HYG, LH, PT |
| *Globocephalus urosubulatus* | hookworm                        |
| *Trichinella spiralis* | trichina worm                    |
| (acanthocephala) |                                  |
| *Macracanthorhynchus hirudinaceus* | thorn-headed worm       |
| **LARGE INTESTINE**  
(nematodes) |                                  |
| *Trichuris suis* | whipworm                         DI, HYG |
| *Oesophagostomum dentatum* | nodular worm                    DI, HYG, LH, PT |
| **KIDNEYS**  
(nematode) |                                  |
| *Stephanurus dentatus* | kidney worm                      |
| **LUNGS**  
(nematodes) |                                  |
| *Metastrongylus elongatus* | lungworm                        LH |
| *M. pudendotectus* | lungworm                         LH |
## EQUINES

<table>
<thead>
<tr>
<th>Name of parasite**</th>
<th>Common name</th>
<th>Therapy*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Habronema sp.</strong></td>
<td>large stomach worm</td>
<td>Bur, Cam, Di, Lp, Mb, Pa, PP, Pt, PCP, TBZ-P, TBZ-T, Tr</td>
</tr>
<tr>
<td><strong>Trichostrongylus axei</strong></td>
<td>hairworm</td>
<td>CAM, TBZ, TBZ-P, TBZ-T</td>
</tr>
<tr>
<td><strong>Parascaris equorum</strong></td>
<td>large roundworm</td>
<td>Bu, Cam, Di, Lp, Mb, Pa, PP, Pt, PCP, TbZ-P, TbZ-T, Tr</td>
</tr>
<tr>
<td><strong>Strongyloides westeri</strong></td>
<td>threadworm</td>
<td>Cam, TBZ, TBZ-P, TBZ-T</td>
</tr>
<tr>
<td><strong>Anoplocephala magna</strong></td>
<td>large tapeworm</td>
<td>Cam, TbZ, TBZ-P, TBZ-T</td>
</tr>
<tr>
<td><strong>A. perfoliata</strong></td>
<td>medium tapeworm</td>
<td>Cam, TbZ, TBZ-P, TBZ-T</td>
</tr>
<tr>
<td><strong>Strongyulus vulgaris</strong></td>
<td>large strongyle</td>
<td>Cam, Di, Lp, Mb, Pa, PcP, PP, Pt, TbZ, TbZ-P, TbZ-T</td>
</tr>
<tr>
<td><strong>S. equinus</strong></td>
<td>large strongyle</td>
<td>Cam, Di, Mb, PcP, PP, Pt, TbZ, TbZ-P, TbZ-T</td>
</tr>
<tr>
<td><strong>S. edentatus</strong></td>
<td>large strongyle</td>
<td>Cam, Di, Lp, Mb, PcP, PP, Pt, TbZ, TbZ-P, TbZ-T</td>
</tr>
<tr>
<td><strong>Phostmayria vivipara</strong></td>
<td>small pinworm</td>
<td>CAM, DI, LP, MB, PA, PCP, PP, PT, TBZ, TBZ-P, TBZ-T</td>
</tr>
<tr>
<td><strong>Oxyuris equi</strong></td>
<td>large pinworm</td>
<td>CAM, DI, LP, MB, PA, PCP, PP, PT, TBZ, TBZ-P, TBZ-T, TR</td>
</tr>
<tr>
<td><strong>Cyathostomins</strong></td>
<td>small strongyles</td>
<td>CAM, DI, LP, MB, PA, PCP, PP, PT, TBZ, TBZ-P, TBZ-T, TR</td>
</tr>
<tr>
<td><strong>Dictyocaulus arnfieldi</strong></td>
<td>lungworm</td>
<td>CAM, Di, Lp, Mb, Pa, PcP, Pp, Pt, TbZ, TbZ-P, TbZ-T, Tr</td>
</tr>
</tbody>
</table>

**LUNGS**
(nematode)

| **Setaria equina**  | abdominal worm               | CAM, Di, Lp, Mb, Pa, PcP, Pp, Pt, TbZ, TbZ-P, TbZ-T, Tr   |

**SMALL INTESTINE**
(nematodes)

| **Oxgulris equi**   | large roundworm              | Bu, Cam, Di, Lp, Mb, Pa, Pp, Pt, PcP, TbZ-P, TbZ-T, Tr   |
| **Cyathostomins**   | small strongyles             | CAM, Di, Lp, Mb, Pa, PcP, Pp, Pt, TbZ, TbZ-P, TbZ-T, Tr   |

**LARGE INTESTINE**
(nematodes)
<table>
<thead>
<tr>
<th>Name of parasite**</th>
<th>Common name</th>
<th>Therapy*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STOMACH</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(nematode)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Physaloptera sp.</em></td>
<td>stomach worm</td>
<td></td>
</tr>
<tr>
<td><strong>SMALL INTESTINE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(nematodes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongyloides</td>
<td>threadworm</td>
<td>DTI</td>
</tr>
<tr>
<td>stercoralis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ancylostoma caninum</td>
<td>hookworm</td>
<td>DEC-S, DI, DIS, DT, DTI, NBC, TC, TI</td>
</tr>
<tr>
<td>A. braziliense</td>
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<td>Uncinura</td>
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<td>DTI, NBC</td>
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<td>DEC, DEC-C, DEC-S, DTI, NBC, PA, PC</td>
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REPORT OF THE COMMITTEE ON IMPORT-EXPORT

Chairman: G. B. Rea, Salem, OR
Co-Chairman: C. K. Jewell, Trenton, NJ


The Committee on Import-Export met and considered problems spoken to a year ago as well as four new topics.

We were updated on the following subjects:

1. The Stewart Air Force Base facility, as a replacement for the Clifton, New Jersey Import Station has been funded at five and eight tenths million dollars and is still expected to be operable by 1979. It will cover 75 acres and provide a greatly expanded import facility.

2. Fleming Key—The first bids were let and found to be unacceptable. This has caused a redesign of facilities and new bids will be let on November 19th of this year. It is expected that this facility will be available by late 1978.

3. Third country cattle imports from foot and mouth infected countries are still authorized, but no requests are pending at this time. This method of importing new genetic strains will be phased out when Fleming Key is activated.

4. The Committee’s request for EIA and piroplasmosis tests on Equidae imported from other countries was implemented this past year.

5. Our request for certification of semen presented for export was not acted on due to the lack of similar requirements by the several states. Several private organizations in the semen export business indicated that they could handle the situation effectively by direct negotiation.

6. The Committee’s request that importers be notified of State animal health requirements which are in addition to those imposed by the Federal Government was adequately implemented by the Import-Export Staff.

7. The Committee’s recommendation that a separate office be established to handle Mexican border problems was studied by APHIS and found not to be feasible at this time.
8. Our concern for the verification of safety of imported milk and milk products has not been satisfied. Under consideration is the UHT (ultra high temperature) procedure presently used by several foreign countries.

9. We received a report on the sealing of galleys and controls of garbage on ships and planes arriving from foreign countries with meat and meat products from Foot and Mouth Disease countries. Plant protection and quarantine, although still not completely satisfied, has increased the number of personnel and is backed up by APHIS personnel. This has improved general surveillance.

New subjects included discussion of the presidential veto of H. R. 10073 dealing with adequate inspection of rabbit meat imported from China and Poland. It is anticipated that a new bill will be introduced into the new Congress with the hope that it will be favorably received.

The continuing problem of strays and smuggled animals being the source of ticks especially, and any of a number of exotic diseases, was discussed at length. It was decided that the present situation posed a serious and potentially explosive situation to the extent that it warranted requesting emergency status to be declared by the Secretary of Agriculture. (A resolution to this effect has been presented to the Resolution Committee.)

Concurrently, with this discussion, was the proposal for expanded research on the efficacy and method of application of pesticides to aid in control and eradication of ticks and horn flies. Secondary, but a highly significant benefit is the reduction of the inroads of screw-worm, through the use of such a pesticide applied by means of materials, A La Dog Collar, etc. A resolution on this subject has also been presented to the resolutions committee.

Representatives from the American National Cattlemen's Association initiated in depth discussions concerning the limiting of cattle, sheep, and semen exports due to embargoes placed by several foreign countries on these United States products. This embargo is caused by the presence of Bluetongue in our herds and flocks. Research funds for study of the adequacy of our testing methods and procedures and knowledge of the location and severity of the problem in the United States is sorely needed. A Resolution was also proposed and presented to the resolutions committee.
REPORT OF THE COMMITTEE ON RABIES

Chairman: R. Keith Sikes, Atlanta, GA
Co-Chairman: E. A. Carbrey, Ames, IA


The Rabies Committee met on November 8, 1976 with a total of 16 members and guests present. During a three hour meeting, discussions were held and appropriate actions taken as follows:

1. A resolution passed by our Committee in 1975 was inadvertently not presented through proper channels in Portland, Oregon. Our committee recommended its re-submission and passage as well as printing by the 1976 USAHA Resolutions Committee. It deals with the national acceptance of a standardized rabies vaccination/health certificate for small animals.

2. A special subcommittee was appointed to coordinate efforts to work with other national organizations to implement this resolution. That committee will be composed of:
   - Dr. Bruce Kaplan, Chairman
   - Dr. Marvin Goff
   - Dr. Jim Glosser
   - Dr. R. K. Sikes

3. The newly revised Compendium of Animal Rabies Vaccines was approved by our USAHA Rabies Committee. Our Committee apologizes for the delay in getting this much needed and up-dated revision of the Compendium of Rabies Vaccines out to every state. The reason for the delay is due to administrative difficulties experienced at the Center for Disease Control. Due to that difficulty, the national Association of State Public Health Veterinarians has accepted responsibilities for revising the Compendium on an annual basis and expects continued cooperation in this activity from USDA and USPHS. Dr. Kenneth Crawford, the Maryland Director of Veterinary Public Health is Chairman of that Committee. This newly revised Compendium will be published in January, 1977. It has the endorsement of two AVMA Councils, as well as the Conference of the State and Territorial Epidemiologists and the Veterinary Biologics Licensees Committee of the Animal Health Industries.

4. Discussions were held concerning classification and standardization for age-specific immunity as well as frequency of booster doses of vaccination in rabies endemic areas. Members of the USAHA Rabies Committee who also serve on the ASPHV Com-
pendium Committee were advised to develop a clear statement on these issues for the 1978 Compendium Committee's consideration.

5. From a recent international rabies symposium held in Atlanta, the chairman summarized advances in human antirabies treatments. The human origin rabies immune globulin is being used widely in the United States. It has virtually replaced the equine origin, rabies serum product. As expected, no adverse reactions have been reported following use of this product. In addition, the newly developed tissue culture inactivated rabies vaccine, using human diploid cells (WI-38 strain) and a production virus strain, has been tested in many hundreds of people in the United States as well as in other selected countries. It has been used as an experimental vaccine following the protocol required of such vaccines under an I.N.D.A. (Investigation of New Drugs Application). All indications thus far are that this vaccine is more potent and biologically cleaner than the duck embryo rabies vaccine. It is currently being considered for commercial licensure. When licensed, it will expectedly allow a reduction of injections from 23 to about 4. Passive immunization will, of course, continue to be indicated in post-exposure treatments.

6. The USAHA Rabies Committee endorses the recommendations and conclusions of the National Conference on Dog and Cat Control which resulted from a meeting held February 3-5, 1976, in Denver, Colorado. We especially support the goals, and the spirit, in which these were written in an effort to improve animal control in the United States.

7. The Committee was honored to have three distinguished representatives from the Dade County Veterinary Medical Association during a portion of our deliberations. Dr. Bob Knowles, noted veterinary practitioner in Miami, Dr. Tom Campbell, president of the Dade County VMA, and their legal counsel, attorney Everett A. Cleary, stated their problem, more legal than technical. In essence, veterinary practitioners have a dilemma in defining whether Dade County is a rabies "high risk area". If so, the literature which accompanies the so called "3-year vaccines" states that these vaccines would be administered annually.

The Dade County veterinarians will accept vaccines for longer than one year if this dilemma of defining "high risk area" is clarified. Considerable discussion was held on this matter which also affects many states and cities in the U.S. The Committee recognized this particular statement was needed several years ago when there was a higher incidence of dog rabies, but it is no longer needed. Further, we know that the rabies vaccine licensed by the USDA Veterinary Biologics are excellent, perhaps the most immunogenic of all veterinary vaccines. Thus, Drs. Al Strating and Jerry Peacock have been
requested to present this matter to the licensees of rabies vaccines and ask that they consider removing it from their literature. Several months to a year will apparently be required to reach an understanding in the matter.

Mr. President, this concludes the report of your 1976 Rabies Committee.

Respectfully submitted
R. Keith Sikes, Chairman
REPORT OF THE COMMITTEE ON
FOOD ANIMAL HYGIENE AND INSPECTION

Chairman: E. Baker, Madison, WI
Co-Chairman: James K. Payne, Washington, DC


The Committee wishes to recognize the loss of Walter Fechner and express its appreciation for his leadership and contributions to the Committee over the past years.

Your Committee received reports on the following subjects:

1. A Pilot Program For Enzyme Labeled Antibodies

   The federal meat and poultry inspection program's project to develop a serological system for continuous inspection of swine for the detection of trichinosis has made significant progress in the past year. A false positive problem that had existed has been largely identified and eliminated. During this fiscal year the test will be further refined, adapted to high speed testing and utilized in a field trial.

   A study of the incremental costs associated with the production of certified pork has been contracted for by MPI. This will enable packers to compare their current costs for producing certified pork by freezing with the serological system if it becomes available for that purpose.

   Your Committee recommends continued effort in implementing this project.

2. Residue Investigation Memorandum of Understanding (MOU)

   A Memorandum of Understanding (MOU) with the states of Delaware, Maryland, Pennsylvania and Virginia, the U. S. Department of Agriculture Regional Office, APHIS, and FDA has been implemented. It is a coordinated investigation program to follow-up USDA reported tissue residues in meat. Eighty-six original tissue residue investigations have been carried out in 1976 by the four states in cooperation with FDA and USDA. Two planning and evaluation sessions have been held with all of the contracting parties. The first meeting was held in April of 1976 in Dover, Delaware. The second in Annapolis, Maryland on October 20, 1976. To the present we believe this pilot program has been innovative and flexible, bringing to bear a uniform approach to producer compliance and consumer protection. To summarize: The avoidance of duplication of investigational efforts and procedures provide better producer compliance and a help in sustaining public confidence in our regulatory agencies.

Veterinary specialists, meat industry personnel, and other interested persons from throughout the United States met in Madison on September 30 and October 1, 1975 to exchange ideas on the problem of swine tuberculosis as a part of the National Conference on Mycobacterial Infections in Swine.

Economic losses due to this disease were reported to be about $5 million in the United States.

Symposium topics focused on the current knowledge and the present status of this swine disease.

Speakers at the two day event viewed the latest information on the etiology, diagnosis, and epidemiology of tuberculosis in swine. One of the purposes was to discuss the feasibility of developing a national eradication program. Symposium participants recommended research needs to further that goal and also questioned the justification of current meat inspection regulations.

USDA and State regulatory agency veterinarians explained epidemiological findings, diagnosis, and control procedures. An exhibit prepared by USDA, National Animal Disease Center veterinarians, displayed tubercular gross lesions and demonstrated the laboratory aids used in diagnosing the disease. Several speakers discussed the public health concerns relating to swine tuberculosis.

Participants included University of Wisconsin as well as State, National and an International authority on tuberculosis. Among the 16 speakers were Dr. Frank Mulhern, Administrator of the USDA Animal and Plant Health Inspection Service; Dr. H. H. Kleberg, Director of the tuberculosis research unit at Onderstepoort, South Africa; Dr. Lawrence S. Farer, Assistant Director of the Tuberculosis Control Division of the Center for Disease Control at Atlanta, Georgia; Dr. W. L. Mallman, Tuberculosis researcher at Michigan State University; and Dr. Roy Corpe, Public Specialist from the Northwest Georgia Regional Hospital.

Following the formal presentations of the symposium, participants were given an opportunity to state any specific needs or requests they thought would help resolve this important disease problem.

Motions or resolutions that were approved included: 1) that a committee be formed to gather known data and act as a clearing house for information on swine mycobacterial infections; 2) that the major areas of research needed involve the fields of veterinary and human public health, transmission, bacteriology, immunology, management and related factors.

Discussion involved the need for an action group, need for peer review, and the designation and acceptance of Livestock Conservation Institute as the coordinating organization. 3) That the nomenclature be modified so that M. avian complex hereafter be referred to not as tuberculosis but as mycobacterial infection or mycobacteriosis.
Discussion involved the difficulty of differentiation between avian and other mycobacterial lesions on postmortem examinations. 4) That we proceed immediately to use the available knowledge and tools to reduce the economic losses to the producer and packer whenever possible. Discussion suggested this be done on a national or unified approach. 5) That industry representatives contact the appropriate officials in the Department of HEW relative to possibly changing the disposition criteria if supplied the supporting data.

Much of the data presented here can be found in more detail in the Symposium Proceedings which can be obtained from Livestock Conservation Institute, 19 W. Chicago Ave., Hinsdale, Illinois.

4. Salmonella Advisory Committee

The Executive Secretary of USDA’s Salmonella Advisory Committee reported on their activities. The Committee charter signed a year ago by the Secretary directed that efforts be made to reduce the incidence of Salmonella in animals, humans and food. In response to the charter, fifteen members representing all facets of the issue met February 25, at which time six subcommittees were identified: 1) Production, 2) Breeder and Hatchery, 3) Feed and Feed Ingredient, 4) Processing and Distribution, 5) Consumer and Education, and 6) Research. At their June 17th meeting the Subcommittees reported on the general direction each planned to take. Recommendations to the Secretary are expected at future meetings. Your Committee recommends that we be kept posted on the Salmonella Advisory Committee activities.

5. Contract Study of Meat, Poultry and Egg Inspection

Meat, poultry, and egg inspection are mandatory services which the Secretary of Agriculture is required by law to provide on demand. Not only can individual processors request and receive inspection, but States which cannot or do not wish to maintain their own inspection systems on a par with Federal standards can turn those responsibilities over to the USDA.

The cost of Federal inspection activities has increased about 15 percent a year since the passage of the modern program legislation. In order to moderate this trend toward higher costs and increasing Federal regulation, there is need to investigate procedures for increasing efficiency in the programs while continuing to assure that the U.S. supply of meat, poultry, and egg products continues to be acceptably branded and unadulterated.

There is some suggestions that the enforcement of complex and stringent Federal inspection procedures may have interfered with growth in the meat, poultry and egg industries and increased costs at both the farm and retail level beyond that necessary for assuring that such products will comply with standards set by the Department.
A. Purpose of Study

The purpose of the study is to review the USDA meat and poultry inspection and egg and egg product inspection programs so as to identify alternative systems that would improve cost-effectiveness, eliminate unnecessary interference in commerce and yet assure that meat, poultry, and eggs for human consumption are unadulterated and not misbranded.

The study will determine the effectiveness of inspection procedures currently used in Federally inspected plants and channels for distribution for detecting different types of adulteration and misbranding in different parts of the marketing system and to propose alternative procedures which could be used to detect them more efficiently. The study will specify for each proposed system the changes in risk to human health, changes in the degree of interference in commerce, and estimates of associated changes in Federal costs.

It will be the purpose of the study to present alternatives for more efficient means of pursuing these consumer protection programs. The principal criteria for efficiency will be: (a) reduced Federal cost per unit of work accomplished; (b) reduced obstacles and reduced costs of preparing products for the consumer market, and (c) acceptable standards for product quality and safety.

B. Conduct of Study

The study proposal should be developed as a study of two separate systems: (1) that involves the marketing of livestock, poultry, and their products; and (2) that involves similarly the marketing of eggs and egg products. Each of these parts of the proposal should identify separately the study plan, organization and costs associated with that part alone. Contracting of the egg and egg products section will be optional.

C. Content of the Study

For each of the two marketing systems discussed in II.B. the study will:

(1) List the major types of adulteration and misbranding that may occur and, for each type, describe where in the food marketing chain from farm to ultimate consumer it may occur; how or why it may occur; the estimated probability of its occurrence; how it may be detected if it has occurred; the potential impact on product demand if it occurs; and the potential consequences to the consumer if it has occurred, including health risk and economic consequences.

(2) In the above context review and evaluate on the basis of available evidence and expert judgment current USDA inspection procedures and staffing regarding their capability and efficiency for detecting adulteration and misbranding at identified critical points in the production-marketing system using current USDA standards. The review of staffing will include the study of current USDA position requirements and organization.
(3) Review current inspection procedures to determine the extent to which changes in them would effect the probability of adulteration and misbranding and in turn the economic and health risks to consumers.

(4) Project to 1980 to 1985 the USDA and State resource requirements for inspection under the current system with current standards assuming a moderate growth in population and real income, sufficient growth in the supply of meat, poultry and eggs to accommodate the demand, and assuring minimal changes from current trends in the structure of meat and poultry industries.

(5) Define and analyze in the context of each of the 1980 and 1985 projections sets of alternative procedures or systems that have potential for implementation and modification of the current system and show the extent to which they minimize:

   a. USDA and other public sector outlays.
   b. Farm-retail marketing costs.
   c. Economic and health risks to consumers and the public in general.

   The development and analysis of potential changes to the current system should also consider:

   d. The extent to which probability sampling techniques can be used.
   e. Technological capabilities and the need for further research and development.
   f. Possibilities for revising current product standards to permit the use of remote monitoring procedures.
   g. Alternative approaches to inspection for achieving the goal of consumer protection including such things as consumer education programs or eliminating sources of adulteration at the farm and other points in the production-marketing system.
   h. Needs for new legislation and significant changes in Departmental regulations.
   i. Sources of potential social or political resistance to specific kinds of changes.

6. Present for consideration by the USDA advisory committee a draft summary of an overall strategy for implementing the alternatives developed at (5) with appropriate documentation of significant impact on costs and other performance criteria of the newly proposed systems.

The Management Consulting Firm, Booz, Allen & Hamilton, Inc. will contact appropriate state officials for input, contacts will primarily be through questionnaire, however, on-site interviews will be held where time permits.

The study is to be completed at the end of nine months.
REPORT OF THE COMMITTEE ON ANIMAL WELFARE

Chairman: A. E. Decoteau, Waltham, MA
*Co-Chairman: J. C. MacFarlane, Pembroke, MA

The Committee on Animal Welfare submits the following recommendations for presentation to the Secretary of Agriculture.

1. To require photographic identification of each dog and cat sold to random source dealers for resale and of the license plate of the car of the persons offering the animals for sale. Purpose of the documentation: to discourage theft of animals for resale and to facilitate successful prosecution in the event of a violation.

   This again reiterates the Committee's concern in the area of dog thefts which cause distress to pet owners.

2. Be it Resolved that USDA is requested to publish final regulations on exercise for laboratory dogs.

3. The Animal Welfare Committee recommends that the provisions relating to multiple surgical operations on a single dog published by the Laboratory Animal Resources in "The Guide for the Care and Use of Laboratory Animals" (page 18) be incorporated in regulations and/or standards promulgated by the Secretary of Agriculture under the Animal Welfare Act.

4. It was resolved that the U. S. Animal Health Association request the U. S. Department of Agriculture to revise Veterinary Services Forms 18-23, Annual Report of Registered Research Facility, to clarify and more accurately reflect the actual use of anesthetics, analgesics, and tranquilizers on animals involved in research, testing or experimentation.

5. It was resolved that the United States Animal Health Association recommend to the U. S. Department of Agriculture that export requirements for the shipment of horses by ocean vessel be revised and strengthened to assure that ship fittings, space, feed and water provisions and such other requirements necessary be adequate to assure the humane care and treatment of horses transported by water.

   A subcommittee was formed to gather information regarding the effects of diesel exhaust fumes on livestock while in transit. If research indicates adverse health effects, then further information be sought on improved exhaust channeling to reduce adverse health impact to a minimum. A report will be submitted to the Animal Welfare Committee at the next annual meeting. Subcommittee Chairman is Mickey Stewart of Nebraska. Members are Christine Stevens, Washington, D.C. and Dr. L. N. Butler of Arizona.

   If anyone present knows of research regarding diesel fumes, please give me a contact name.

*Not present at committee meeting.
REPORT OF THE COMMITTEE ON
STATE FEDERAL RELATIONS

Chairman: A. E. Janawicz, Montpelier, VT

APHIS Veterinary Service Review

Brucellosis

The Committee has considered the proposed 10 year Brucellosis eradication program which, in effect, is a 5 year program for eradication in a state, approached nationwide on a staggered basis. The Committee feels it is a reasonable and feasible approach to the problem, and one that both the organized profession and industry would support, provided there is an open commitment that USDA will implement and forcefully adhere to its provisions. We are convinced that there should be no compromise with the goal of eradication. Any lesser approach compromises our obligation to the protection of public health and the nation’s economy.

We urge that top administration and policy makers adopt this plan as a top priority item, and make every effort to make the continuing commitments it requires.

Hog Cholera

In the current Hog Cholera outbreak, two and one fourth million dollars has been spent for indemnities, and almost $1,000,000 for support. This outbreak can most likely be attributed to the feeding of improperly cooked garbage. The threat still is that, it appears there may be infected pork in trade channels involving at least 17 states. We were told in the past, that when sufficient states had outlawed all feeding of garbage to swine within their jurisdictions, that USDA would then move forward toward banning this practice nationwide. Fifteen states have now done this, and again garbage emerges as the principal culprit for perpetuating the disease. The time has come to ban garbage feeding nationwide.

Other Diseases and Activities

The Committee is pleased with the progress in obtaining additional physical plant facilities and the laboratory backup services that are being provided and planned.

The Committee wishes to express support for the ongoing animal disease eradication programs, and feel that at least, acceptable progress is being made with the exception of the following:

(1) Bovine T.B.
(2) Scabies and Ticks
(3) Anaplasmosis

We urge additional support in these areas.
Manpower

In the face of severe manpower restrictions being imposed by Federal authority and some states, we cannot permit the situation to deteriorate to the point where animal health programs lose their effectiveness. We urge USDA to establish a small task force on manpower (both professional and sub-professional,) made up of representatives from USDA, AVMA, USAHA, and the field of education to seriously study the problem and develop alternative approaches towards a solution. Several alternatives suggest themselves singly or in combination. Those are:

1. Increased Federal employee staffing.
2. Increased State employee staffing.
3. Increased use of temporary employees.
4. Fee basis commitments on part of outside personnel based on either full time or part time service.
5. Contractual arrangements for specific or area oriented tasks and strictly governments supervised.

There are undoubtedly other alternatives or combinations, but the time to bring the major concerned elements together, both in and out of government, to seek solution is now.

Meat Inspection

The Committee continues to commend APHIS for maintaining a most outstanding Consumer Protection Program involving meat, poultry, and the products associated with the allied industries. The program presents a most significant insurance as well as assurance to the citizens of this nation.

It was most gratifying to be informed that the finances of this program had improved since our last meeting and we commend the administrators for this improved situation.

The Committee was advised that a total of 17 states now have federal programming in poultry inspection. It was further advised that now the nation has a total of approximately 9000 federal plants representing 90% of the total product in relation to 7400 state inspection plants 10% of the total product. In answer to direct questions, staff of meat inspection indicated that in some of the recently designated states the number of needed personnel was reduced and that costs were reduced, particularly in states where salary structure were higher than federal.

The Committee then discussed how the industries received designation status in the recently involved states. Consensus, with rare exceptions, indicated that industry has accepted the designated programs.

This Committee expresses sincere concern for the continuation of separate programs that are supposed to be of equal status but in
reality provide for state programs that are not equal. If state inspected plants are of equal status, the product from the plants should enjoy the same freedom of movement as federal product. This causes state administrators as well as state policy makers to view state programs as discriminated. The overall economics involving judicial use of governmental funding provides the need for serious consideration of an 80-20 federal funding program.

Perpetuation of state programs that are equal to the federal program, but having in reality discriminated programs, is a great injustice to the industry as well as to the taxpayer. The Committee points out that in many of the designated states the program carried out presently is less stringent than that program previously required to be carried on by the respective states.

The Committee commends APHIS Meat Inspection for its efforts in assisting the animal health inspection officials with their programming at plant level. It is further recommended that all effort be put forth to enhance communications with animal health and meat inspection personnel to improve the availability of trace-back animals in programs involving such effort. The Committee is cognizant of the need for a better identification system that would benefit not only animal health programs but also involves public health programs.

The Committee was informed of a Model Uniform Retail Store Ordinance. The Committee recognizes a dire need for this type of uniformity and recommends serious pursuit of this effort.

The Committee recognizes the need for protective residue programs. APHIS Meat Inspection is commended for the pilot program involving Virginia, Maryland and Pennsylvania. All effort should be made to enhance communications to provide expedient traceback to the involved premises.

This Committee encourages the USDA, APHIS and the Food and Drug Bureau of Veterinary Medicine to cooperatively participate in a National Salmonellosis Symposium to be conducted by the USAHA Salmonella Committee sometime in 1977. It should be pointed out that the Council of Public Health and Regulatory Medicine of the AVMA has passed a resolution to cooperate in such a program.

_Agricultural Research Service_

Our Committee reviewed with the ARS staff, the present and projected research programs related to diseases and parasites of livestock and poultry. We are gratified to learn that suggestions made by this Committee in previous meetings, have been considered, and progress is being made in a number of areas that were of grave concern.

An example of this are the research projects in progress, or
planned for Brucellosis. While the eradication program enjoyed considerable success with the tools at hand, it became more and more evident that in order to complete the job with minimum delays and expenditures some new diagnostic and/or immunizing agents may be needed. The ARS research for a cell component that would be non-infective, but render immunity is a step in the right direction, and we hope will be given high priority. Review and revaluation of strain 19, which is being conducted is also long overdue. Hopefully, more specific and effective diagnostic methods will develop from some of these projects as we learn more intricate details of the disease. We urge ARS and APHIS to continue to cooperate in all facets of these projects to gain the maximum expediency in completing these studies.

We are still deeply concerned about the prospect of the introduction of foreign animal diseases into the United States, particularly foot-and-mouth disease. Recent discoveries regarding the survival of FMD virus in meat and milk products even after processing, and pasteurization, are placing new threats to our country. More recently ARS has reported the survival in pork casings and certain cheeses that heretofore were thought to be free. The Committee urges continued investigation and research of the survival of FMD virus in meat and milk products, such investigation to determine approval of imported meat and milk derivatives for addition to processed meat and milk products. We support and urge increased emphasis on the FMD vaccine studies being conducted, in case eradication is not possible or feasible. This includes the construction of a vaccine production plant, warehouse, animal facilities, and increased laboratory space.

Pseudorabies losses in swine have doubled in the past year. While this has been confined to certain few states and areas, we urge a high priority be placed on research for a new diagnostic method to assist in preventing further spread in our swine population as well as other species.

Respiratory diseases of cattle are still responsible for serious losses. Our Committee would urge continuing research in this field to reveal agents involved, diagnostic methods, and control or eradication methods.

We support continuing research for immunizing agents for equine infectious anemia, foot rot in sheep and pink eye in cattle.

The discussion regarding the area control of insects and insect vectors rather than the present individual animal or herd concept, aroused some new thinking in this field. Hopefully, ARS staff will develop recommendations and programs in this area.

An increased interest in poultry diseases and the need to give further attention to the problems in the production area rather than establishing controls and programs relating to the products. A case
in point is the ongoing interest in Salmonella and drug residues. In the latter area we urge close cooperation with FDA, as well as APHIS to define the problems precisely, and attempt to head off the problem before it causes economic chaos to the industry.

While there seemed to be no serious complaints from ARS staff regarding manpower, our discussions with other agencies causes concern that the present personnel ceilings could have adverse effect in development of much needed new programs or even the needed expansion of existing ones. This Committee is willing to lend support at anytime or wherever needed, if we are kept informed of the needs and requirements.

We appreciated the opportunity to meet with staff, and look forward to future cooperation between APHIS and the United States Animal Health Association.
REPORT OF THE COMMITTEE ON INFECTIOUS DISEASES OF HORSES

Chairman: C. L. Campbell, Tallahassee, FL
Vice Chairman: W. O. Kester, Golden, CO


The Committee on Infectious Diseases of Horses met in Miami Beach on November 8, 1976, with approximately 35 to 40 committee members and visitors present. A number of items of importance to the horse industry was discussed.

At the 76th Annual Meeting held at this hotel four years ago, a resolution emanated from the Committee on Infectious Diseases of Horses and was adopted by the Association urging that the Secretary of the Department of State and the Secretary of the Department of Agriculture take steps for the United States to become a fully participating active member of the Office of International Epizootics. It is gratifying to note that within the past year the United States did attain membership in the OIE, which will help in keeping abreast of world animal disease situations. We wish, therefore, to commend the Departments of State and Agriculture for their action to this end.

For several years this Committee has pressed for, and the Association has concurred by resolution, passage of import regulations requiring the AGID test on all horse stock entering this country. We are pleased to report that such regulations have now been implemented, and the Committee wishes to express appreciation to the U. S. Department of Agriculture for its action.

The Committee had the opportunity to view the movie recently revised on Equine Infectious Anemia. The inclusion of the AGID test procedure and more recently developed scientific data certainly improves the quality of this film, which is intended for horse owner audiences. The film is available not only through extension sources, but from area Veterinarians in Charge and the Veterinary Services headquarters in Hyattsville as well.

You will recall in last year's report that 34 states had at that time adopted requirements for negative EIA test for entry into those states, nine of which had additional regulations requiring negative tests for animals entering assembly points or for public or private sale. It was reported that currently 40 states have EIA entry requirements, and ten of the 40 have the additional intrastate requirements for assembly or sale purposes.
The Committee received information that 14 states now have no requirement on the identification of horses reacting to the EIA test. This provides for great difficulty in many instances to control the movement of these animals, and it is only sound disease control and eradication procedure to identify infected animals, and the Committee therefore urges these 14 states in the national effort to implement regulations which would provide a method of identifying EIA reactors.

The members were apprised of an Equine Infectious Anemia Research Workers Conference held in New York City on July 27, 1976, sponsored by this Association's Committee on Infectious Diseases of Horses. The report which was developed as a result of this conference has received wide circulation, and in the interest of determining whether there might be dissension on the part of individual committee members on the various points made therein, it was reviewed in toto and a motion was passed that the Committee concur in and ratify the report as published. A copy of the report is attached and made a part of this report.

In 1974 this Committee refined the guidelines for a state control program for equine infectious anemia, which still contain valid parameters in dealing with EIA infected herds. Therefore, those states contemplating any action toward the implementation of regulations directed to controlling the disease should utilize these as current guides until further revision is offered by the Committee.

Comment ensued upon the apparent resentment of horse owners in not having negative EIA test papers checked at horse assembly points or in crossing state lines in too many instances, and relevant discussion disclosed that this was largely a problem of inadequate manpower to police such movements. In some areas horse show management is taking the responsibility for enforcing EIA test requirements, which efforts should be commended and encouraged in other areas where the lack of sufficient regulatory manpower is a contributing factor. It was suggested that law enforcement officials be encouraged to assist in further policing of the regulations.

In previous reports the Committee has emphasized the importance of horse identification as essential to disease control, as well as for legal and commercial aspects. The Committee reaffirms that this continues to be a problem and iterates the need for a practical means of identifying horses.

In spite of repeated attempts to stimulate the tabulation of the current horse population within the United States, no progress has been made in obtaining such a census. This Committee still feels that an urgent need exists for such information and recommends that the U. S. Department of Agriculture renew its effort toward the accomplishment of this goal which is essential to equine disease control.

C. L. Campbell, Chairman
Respectfully submitted
REPORT ON EQUINE INFECTIOUS ANEMIA RESEARCH
WORKERS’ CONFERENCES

Clarence L. Campbell*, DVM and W. O. Kester*, DVM

Meeting was called by the U.S. Animal Health Association and chaired by Drs. Clarence L. Campbell and W. O. Kester. Research workers participating were Dr. Charles Issel—Louisiana State University; Dr. Vincent Saurino—Florida Atlantic University; Dr. Leland Grumbles—Texas A&M University; Dr. Leroy Coggins and Dr. Matt Keman—Cornell University; Dr. S. Lynn Kittleson and Dr. Robert Tashjian—New England Institute of Comparative Medicine; Dr. Fred Neal and Dr. Jack Gaskin—University of Florida; Dr. James Pearson—Veterinary Services Laboratories, U.S.D.A., Ames, Iowa. Participating also were Dr. Ralph Knowles, Chief Staff Veterinarian, Equine Diseases, U.S.D.A.; Dr. J. C. O’Connor—President, American Association of Equine Practitioners; Dr. Charles Dunkin—New York Assistant State Veterinarian; Dave Goodman, U.S.D.A.; Dr. R. A. Greene—Editor of “Horse of Course”.

The principal purpose of the meeting was to review developed scientific data and to arrive at a consensus on certain aspects of equine infectious anemia in order to preclude erroneous information being released to the public.

The majority of institutions in the United States involved in E.I.A. research was represented. Progress reports and research plans were presented by each. The value, accuracy and use of the agar gel immunodiffusion test, otherwise known as the Coggins test, were reviewed and the opinion of the conference is summarized below.

It was agreed that the role of the AGID test positive horse which shows no clinical signs of E.I.A. is the number one problem and should receive top research priority. Statements were noted in a few horse periodicals indicating the belief that such horses are not a potential disease spreader under natural conditions and consequently need not be quarantined. It was the consensus that this might be true in a proportion of the horses but data presented at the meeting by antagonists, as well as protagonists, of this concept demonstrated that inapparent carriers have served as sources of virus for transmission under natural and experimental conditions.

Some of the things the test can and is doing for serious minded horse breeders and owners are:

1. By requiring a test prior to purchase a buyer is now reasonably sure he is not running the risk of bringing home an infected horse as a potential spreader of the disease.

2. By requiring a test before admitting a visiting mare or any

*Co-Chairman Committee on Equine Infectious Diseases
**Held in New York City, July 27, 1976
other horse on a breeding farm a breeder is reasonably sure that no spreader of the disease is on his premises.

(3) By requiring a test prior to acceptance the operator of a training stable, center or farm is reasonably sure no spreader of the disease is among his stable of horses.

(4) An auction sales company by requiring a test prior to selling now knows and can reasonably assure their customers that they will buy no positive reactor or potential disease spreader.

(5) Insurance companies by requiring a test prior to insuring a horse can assume with safety that the policy is issued on a healthy animal not infected with E.I.A.

(6) A veterinarian in issuing a health certificate knows that if a Coggins test is allowed and included he has done a more thorough job for his client.

(7) The show horse owner exhibiting at a show where a test is required prior to entry is reasonably sure that his horse will not be exposed while on the show grounds (even though the requirement is not fully enforced).

(8) Race horse owners now know there is essentially no chance of their horse being exposed at a race track because practically all tracks now require a negative test prior to acceptance at the track.

It was noted that race track management learned years ago that if they were to attract valuable horses the best possible assurance must be given that E.I.A. was not present. This was done by requiring a negative test on all horses racing at tracks and by educating horsemen on how the disease was spread from horse to horse on hypodermic needles. It is generally accepted that all recorded outbreaks that have occurred at race tracks in the United States have been caused by the transfer of E.I.A. virus primarily from asymptomatic carriers to susceptible horses by means of hypodermic needles or other instruments in common use. Significantly no new outbreaks have been reported at tracks since use of the Coggins test has been implemented as a protective measure.

(9) Obviously the Coggins test whether voluntary or required has removed a large number of potential disease spreaders from the horse traffic pattern, thus vastly reducing the probability of future outbreaks.

Test Limitations

The term “reasonably sure” is used in the foregoing because in veterinary medicine there is no sure thing.

The tight surveillance and quality control system exercised by U.S.D.A. over the complete laboratory testing program was reviewed and it was agreed that the Coggins test was probably one of the most accurate biological tests yet developed in either human or veterinary medicine. With the exception of some foals with passive antibodies, false positive reactions have not been confirmed. It was
observed that in extremely rare instances a very weak positive reactor might be most difficult to read and that in spite of their intensive training could be recorded as negative by personnel in one laboratory and not by another; thus, further emphasizing the role and need for the U.S.D.A. Veterinary Services Laboratory, Ames, Iowa, for reference on questionable cases.

It was reaffirmed that foals may give a false positive reaction while nursing positive mothers, and that the Coggins test cannot differentiate the infected foal from the foal with passive antibodies until about six months of age. Further, badly diseased horses sometimes give false negative reactions. It was noted that the same pertains to practically all comparable tests in man and animals and, while the individual horse which is the exception might pose a problem, the numbers involved in either category are infinitesimal. Also, the foal with passive antibodies is not a threat and soon corrects itself, and the false negative badly diseased horse being clinically ill will limit its disposition irrespective of test results.

It was reaffirmed also that the Coggins test may miss horses recently infected and that the same pertains to all other long useful diagnostic tests. No animal can be found positive for any disease until he has been infected long enough for the body to develop measurable antibodies or other evidence that the disease agent is present. This period may range from a very few to several days and is why followup tests are required in most disease regulatory programs.

It was recognized that none of the foregoing limitations was reason for doubting or not using the Coggins test because these limitations have long been known in veterinary medicine and understood, managed and eliminated as practical problems in connection with E.I.A. as well as many other diseases.

Regarding the asymptomatic test positive reactor horse the following was reaffirmed:

1. It has been established that some are potential spreaders of E.I.A.
2. It has not been established that all are potential spreaders.
3. It has not been established that any are not potential spreaders.
4. No practical means exists for differentiating between a potential spreader and a possible non-potential spreader.
5. In light of existing knowledge, for regulatory disease control purposes, all must be regarded as potential spreaders of E.I.A.

In discussing other specific problem areas the following was reaffirmed:

1. Horses known to have been infected virus carriers remain carriers throughout life.
2. Adult horses known to have been positive reactors to the Coggins test remain positive reactors indefinitely.
3. Under proper conditions a considerable percent of disease free foals may be produced and raised from E.I.A. infected stallions and/or mares.
(4) Instances were reported where an infected stallion was safely used on disease free mares. One mare with a vaginal injury was believed to have become E.I.A. infected through virus carried in semen.

(5) Virus has been transmitted by horse flies under controlled conditions from asymptomatic carrier horses to susceptible horses but less readily than from acutely infected horses wherein virus transmission has been demonstrated by a single horse fly.

(6) Species of horse flies are believed to be the principle E.I.A. vectors in nature.

(7) Studies on fly behavior and practical experience indicates that a two hundred yard buffer zone as practiced in some states is an acceptable barrier for quarantine purposes. Effective quarantine requirements may vary with the time of year and geographical location.

(8) In view of findings in recent research done with washed leukocytes, work is now underway to further extend the efficacy of the animal inoculation test.

(9) Research on chemotherapy should be continued; however, success in the near future is not foreseen.

(10) Research on vaccine development should continue. Again, success in the near future is not foreseen.

It was agreed that existing control programs had problems and did not appear to be popular in some areas. However, no one could advance any plan or ideas that might improve them. One participant (Dr. Greene) recommended that all control programs be discontinued. It was suggested that test positive reactor horses be released from quarantine if they could clear three negative animal inoculation tests. This will be considered but past experience indicates few if any would be cleared through such procedures. Further, the procedure would be extremely time-consuming and expensive.

It was reaffirmed that research should be continued and expedited in the following areas:

(1) Role of the A.G.I.D. test positive horse that shows no clinical symptoms—is he or is he not always a potential disease spreader under natural conditions and, if not, how does one differentiate between the potential and non-potential spreader horse?

(2) Vaccine development.

(3) Chemotherapy treatment.

(4) Role of insects as vectors.

(5) Chemical disinfectants.

(6) Better defining of the mare-foal relationship and the stallion-mare relationship when either or both are infected with E.I.A.

The next E.I.A. researchers’ meeting is scheduled for the Spring of 1977 at the U.S.D.A. National Animal Disease Center, Ames, Iowa. Informal sessions are anticipated in Miami Beach this November in connection with the annual meeting of the United States Animal Health Association.
REPORT OF THE COMMITTEE ON EVALUATION AND DEVELOPMENT OF STATE-FEDERAL PROGRAMS

Chairman: J. L. O'Harra, Reno, NV
Co-Chairman: Douglas R. Stauffer, Pickerington, OH


The U. S. Animal Health Association Evaluation and Development of State-Federal Programs Committee met at 1:30 p.m. Thursday, November 11, 1976 with eight members and seven visitors present. The 1975 Committee report was reviewed and the Committee requested an updating on the situation in regard to filling Federal positions and other activities to increase efficiency in program management. The Committee was pleased to receive information that the hiring process for Federal employees has been speeded up considerably although some damaging delays still exist. The Committee commends APHIS on the progress made in overcoming hiring delays that have existed under the present Civil Service procedure. It is recognized that Veterinary Services continues to operate within a ceiling, although some relief appears to be forthcoming.

A discussion was held by the Committee in regard to allocation of resources under the present accelerated Brucellosis Eradication Program. It was determined that resources are being utilized in those areas capable of most effectively using that additional support.

The Committee recommends that both State and Federal agencies reevaluate manpower assignments on a field level and provide more effective supervision to avoid overlapping assignments and duplication of effort.

The Committee recommends that a program be inaugurated on a State-Federal level in regard to the eradication of Pseudo-rabies in swine. The Committee also strongly recommends new funding for this program and that it not be developed at the expense of present ongoing programs. The Committee expressed concern regarding the production and uncontrolled distribution of Pseudo-rabies serum and urges that each state take the necessary steps to develop adequate controls for such biologics.

The Committee has presented two resolutions to the Resolutions Committee for consideration, one resolution in regard to apathy in the cattle scabies eradication program, the other in regard to the cattle fever tick situation.

The Committee was apprised of the cost relative to operating Veterinary Services Laboratories at Ames, Iowa, and urges a continuing effort to negotiate reduction of overhead charges.

Mr. Chairman, the Committee respectfully submits this report to the Executive Committee for consideration.
The annual open meeting of the Mastitis Committee of the United States Animal Health Association was convened at 1:30 PM on November 8, 1976. Six guests and six members were present.

The Mastitis Committee last year considered a resolution regarding finite and zero tolerances for drugs in edible animal products. It was referred to this year's Biologics Committee for their consideration. A recommendation was made by this committee that this same resolution be submitted to the Pharmaceutical and Toxicology Committee for their consideration.

This committee recommends that the Executive Committee of the United States Animal Health Association request the National Mastitis Council to appoint a representative to be included in this Mastitis Committee.

Dr. K. M. Weinland described in detail the results of coordinated herd health programs on mastitis control in Indiana dairy herds.

A discussion was held about established somatic cell limits in milk for interstate shipment. This committee recommends that the limit of one and one-half million somatic cells per milliliter in milk for interstate markets be lowered to one million.

This constitutes the report of the Committee on Mastitis and we respectfully submit this report for approval by the Executive Committee.
REPORT OF THE COMMITTEE FOR ZOOLOGICAL GARDENS

Chairman: R. M. S. Temple, Aurora, OH  
Co-Chairman: Dale Schwindaman, Rockville, MD

Keith Sherman, Secretary; George Pierson, Gordon Pierson, Gordon Hubbell, John Banks; Visitors: Mr. Charles Chase, Dr. Mort Silberman, Dr. Ronald Scott

The Committee for Zoological Gardens met at 1:30 PM on Wednesday November 10, 1976, with the above committee members present.

Dr. Temple called the meeting to order and discussed the purpose and objectives of the committee.

Dr. Dale Schwindaman, Senior Staff Veterinarian, Animal Care Staff, USDA, Veterinary Services, discussed the 1976 amendments to the Animal Welfare Act and their affect on zoological exhibitors. Most of the amendments deal specifically with dogs and cats, but the amendment requiring health certificates to accompany animals when presented to common carriers and intermediate handlers for transport will involve not only dogs and cats, but also include non-human primates. The regulations are being prepared for publication in the Federal Register as a proposed rulemaking, but at this time, the exact regulations have not been promulgated.

A discussion was carried on with regard to reintroduction of a bill in Congress that would establish a commission which would regulate humane care, treatment and handling of birds, horses, reptiles, farm animals, as well as other animals covered by the Animal Welfare Act. At this time, the legislative status of the bill is not known.

Dr. Sherman, APHIS, Veterinary Services, Animal Care Staff discussed the move by the Department of Agriculture to remove "aquatic animals" from the list of exempt animals which would allow for captive marine mammals to be covered by the Animal Welfare Act of 1970. Minimum standards are now being drafted which will be published in the Federal Register as a proposed rulemaking as soon as the Department's legal council gives approval. February 1, 1977 is the target date for the publication of the proposed standards.

The members of the committee voted to draft a resolution to be presented to the Executive Board of the USAHA, (resolution at end of report).

The committee wished to make a statement in support of a recommendation made by the American Association of Zoo Veterinarians that the national tuberculosis reporting system computerize data relative to post mortem findings and laboratory cultural results and to standardize tuberculin testing methods used among zoo animal collections in regard to tuberculin types, injection sites, dosages and interpretation of responses.

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The committee wishes to support the position that was taken by the American Association of Zoo Veterinarians in handling this problem as will be published in the American Journal of Zoo Animal Medicine.

Dr. Pierson, APHIS, Veterinary Services, Import-Export Staff discussed a proposed rulemaking requiring that all commercial birds be in the country of origin for at least 90 days prior to importation into the United States, and that during the last 30 days prior to export the birds be under the supervision of the National Veterinary Services of the country.

The Advisory Committee on Poultry Health to the Department of Agriculture recommended that personally owned pet birds be handled in the same manner as other avian imports. It is planned that appropriate amendments will be prepared.

Mr. Chairman, we hereby submit this report for the consideration of the Executive Committee of the U. S. Animal Health Association.
The development and use of standardized diagnostic and reference reagents and methods have been goals of scientists for a number of years. This concept has been pursued actively and extensively by a number of national and international organizations and agencies such as the American Type Culture Collection (ATCC), the National Institute of Health (NIH), Center for Disease Control (CDC), World Health Organization (WHO), and the U.S. Animal Health Association (Committee on Animal Virus Characterization, and Committee on Biologics). This paper is presented on behalf of the Biologics Committee of the USAHA.

The main objectives of the presentation are: (a) to review the status of standardization in microbiology, (b) to present sources of information and program development which are currently available and (c) to restate the needs for a meaningful involvement in this area of activity by the USAHA.

The ATCC, incorporated in 1947, was an early pioneer in this area. The agency has a stated goal, that of collecting, propagating, preserving and distributing authentic cultures of microorganisms and cell substrates. As a part of their activity, they have ensured the authenticity of all materials in the collection and have improved and standardized methods for the use, storage, handling and shipment of the materials. It is the repository for a large number of authentic cultures of microorganisms and certified cell lines. Information on the identity, characteristics, preferred methods of culture, etc., is provided by the ATCC for each of the items available for distribution.

The International Association of Biological Standardization, started in 1955 as a section of the International Association of Microbiological Societies, became the International Association in 1971. The aim of the society is to inform members of all matters concerned with the standardization of biological substance and to publish papers concerned with the subject. To this end, the association plans and conducts international symposia, publishes the proceedings of these symposia and publishes the Journal of Biological Standardization.

The Research Resources Program of the National Institute of Allergy and Infectious Diseases (NIAID), NIH, began a Virus Reagent Program in 1961. Its purpose was to produce, test, and distribute reagents designed to serve as reference standards. The application for these identical reference materials was to encourage meaningful comparative virus studies. Subsequently, the program was extended to include mycoplasmas, interferons, and allergen-associated
reagents. The reference standards produced were extensively studied and tested by a number of laboratories. They were produced under NIAID contracts with industry, universities, and nonprofit organizations and certified by independent laboratories. Availability is limited; however, the documentation provided for each reagent provides the user with a complete history of the material.

In 1961, the Third International Laboratory for Biologicals Standards was established at the Central Veterinary Laboratory at Weybridge, England. This laboratory, established under the sponsorship of the World Health Organization/Food and Agriculture Organization (WHO/FAO), undertakes the preparation, storage and distribution of WHO international biologicals that are of primary veterinary importance.

In 1962, CDC published a "Viral and Rickettsial Reagents Procedural Manual" which provided an outline for the preparation of antigens and specific antiserum. This step-by-step procedure was designed as a guide for standardized laboratory study.

More recently the American Association of Avian Pathologists published a manual of standardized procedures for identifying avian pathogens. This compendium of information furnishes the user with guidelines for the isolation and identification of microbial pathogens which affect avian species, and with the material, techniques and references essential to establish a diagnosis.

Lastly, "The World Federation of Culture Collections" was established with the goal of serving to collect, collate and disperse information on the practical aspects of isolation, identification, preservation, manipulation and management of microbial cultures.

The widespread use of microorganisms in research, teaching and industry emphasizes the need for well characterized reagents and standardized techniques to serve as reference reagents and procedural guides. An authentic, properly characterized and reliable reagent, is absolutely essential for comparative purposes with unknowns.

The availability of this type of reference material offers advantages such as: (a) providing standard material, free of contaminants and with known passage history, which can be used for systematic demonstrations in teaching programs; to assay for antigenic drifts; and to monitor for genotypic or phenotypic changes in disease inducing microorganisms, (b) providing a source of unusual or atypical microorganisms that may be difficult to acquire and (c) eliminating the time-consuming and expensive efforts needed to maintain culture stocks essential for a number of purposes.

Considerable efforts in defining standards of reagents for virology have been made. Several years ago the Western Hemisphere Committee on Virus Characterization, (presently the Committee on Virus
Characterization of the U. S. Animal Health Association), defined a number of viruses and established suggested criteria for the production of both the reference virus agents and reference antisera. Subsequently, the Western Hemisphere Committee on Animal Virus Characterization published a listing of animal reference virus recommendation containing more than 200 viral strains then distributed among fifteen distinct viral groups. This compendium\(^6\) was updated in 1975 to incorporate the latest changes in nomenclature and to add new viruses to the list. As stated in the publication the committee recommended the adoption of certain specific viral strains as references, to be used for a number of purposes: (a) the identification of new isolates of virus, (b) the standardization of viral reagents and vaccines, and (c) for use in studies in comparative virology, epidemiology and disease etiology.

The early work of this committee was extended and incorporated into the present World Health Organization's program on Comparative Virology. I would like to present the definitions and requirements for establishing reagents as adopted by this group.\(^9\) Reference reagents are defined as follows: (I) Virus strains (a) A reference strain should as far as possible meet all the acknowledged characteristics of the virus. Its antigenicity must be such that it is truly representative of its serological type. The virus should also be readily workable. (b) It should be a strain which has been sufficiently characterized so that a thorough evaluation of its properties can be made. In some instances the virus chosen will be one that has been characterized and has properties most desirable for a reference virus and not be the original or most frequently described isolate. The selected reference viruses should not be termed prototype viruses although in some instances they may be one and the same. (c) The virus should be as near as possible to the original isolation in respect to the number of transfers in order to minimize the chance of mutation and the risk of contamination with other agents. (d) It should be propagated in a host system that minimizes the chance of admission of foreign agents. It should grow in a host that is completely characterized and free of any infectious agent. (e) The virus should be purified by such biological, physical or chemical means as necessary to insure its greatest specificity. (f) The purified virus should be checked to confirm its identity using physical-chemical tests, biological tests and serological tests. It is obvious then that the need for a completely defined and characterized diagnostic or vaccine virus must of necessity require intensive study prior to its adoption.

(II) Reference Sera; Two grades of standardized sera are recognized: Grade 1 and Grade 2. All other sera not meeting the specifications for these grades are designated as “working sera”. Working sera should, however, be prepared using a virus which has had some preliminary purification.

Requirements for reference sera follows: Grade 1. A grade 1
serum is a reference serum prepared in gnotobiotic animals. It would meet the requirements for adoption as an international reference reagent. The virus used for antigen preparation must satisfy the requirements for "selection of reference viruses" specified by international agreement.

The method used for the production of the antiserum should be such as to ensure that the final preparation contains antibodies only to the single virus in question, within the limits of present day knowledge or technology. Inoculation of gnotobiotic animals with the virus material should be by a natural route wherever possible. Before inoculation, the antigen must be certified as free from any contamination detectable by known methods and if possible free from any other foreign protein. The sera so produced should be potent, specific, stable, and tested by two or three different laboratories before acceptance of this serum as a grade 1 product.

Grade 2. A grade 2 serum is a reference serum normally prepared in conventional animals. The requirements for specificity and freedom of the virus from contamination as well as the techniques for checking serum by other investigators should be the same as for grade 1 sera. The final serum preparation will not necessarily be free from antibodies to agents other than those of the virus group in question.

Once we have defined and produced reference reagents whether they be for microbiology, toxicology, immunology, parasitology, etc., we must then consider the use of these reagents. Reference reagents (especially viral) must also be discussed in conjunction with the cell substrate or host system utilized. Not only must the virus be critically analyzed and characterized but so must the cell type used. Many cell lines used are not stable, not genetically defined and not free from adventitious agents. The fluids used for cell growth and maintenance must also be certified. A recent testing of commercially available fetal bovine serum revealed that over 30% of the lots tested contained bovine viruses. Similar reports document bacterial virus contamination of fetal bovine sera and viral vaccines.

Standardized reference antisera and working antisera must be used in meaningful comparative test assay systems. The virus-antibody interaction are an important aspect of disease investigation. The results obtained may be influenced by time, temperature of incubation, volume of fluid in which the test is conducted (i.e. microtiter vs macrotiter system), susceptibility of the host system used, and the time interval at which virus effects are read.

When all of these interactions are considered it can be seen why it is difficult to compare the results obtained by different laboratories unless standardized procedures are used. For example, and this has been seen in published reports, one laboratory using the plaque reduc-
tion test may designate a 50% reduction as significant, whereas other laboratories may consider different percent reductions, e.g. 70%, 80% or even 90%, to be significant. Are all of these test reports designating the same thing? I doubt it. There are reports available in published literature showing that an 80% plaque reduction is significant. Is then the use of a 50% plaque reduction justified?

In addition, some laboratories use recent isolates as diagnostic reagents without having compared these isolates to well established and characterized serotypes. It is difficult to see how comparisons in producing diagnostic data, in producing vaccines, in testing vaccines, and in epidemiological investigations can be correlated unless some effort is made to standardize the reagents used and the methodology for conducting tests.

Lastly, we must consider the aspects of clinical or diagnostic relevance versus the precise identification and typing of infectious agents and/or their by-products. Precise identification and characterization have epidemiological implications relating to the origin of infection and the maintainence of the source in the ecosystem, and are essential if appropriate control measures are to be applied.

Yet, many diagnostic laboratories do not have the resources required of a reference center and are locked into a pure service function of providing rapid answers the clinical veterinarian can use. Abbreviated methods of laboratory diagnosis do have merit in rapidity, economy and speed of initiating treatment and control measures. In addition commercial concerns find it uneconomical to stock strains of microorganisms having a low demand or profit potential. As a result, sources of reference type reagents are limited, and those available are frequently not used because of time and budget restrictions.

However, the development and use of reference material or standards and the performance of standardized tests are essential if we are to effectively diagnose, control or eradicate diseases. Developing standards for laboratory diagnostic products will permit us to: (1) generate reliable laboratory data, (2) establish uniform diagnosis and treatment of disease, (3) provide a basis for inter-laboratory comparisons and (4) provide a common ground for a more meaningful dialogue between diagnostic laboratories, clinicians, researchers and regulatory agencies.

The involvement of the Biologics Committee of the USAHA in this area of activity is essential. The Committee should provide the USAHA with guidelines for the specifications and test systems and coordinate with National and International Organizations involved in similar programs. Without reference reagents and standard protocols, Microbiology may become strangled and so will effective disease control programs.
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PROBLEMS IN THE FIELD EVALUATION OF LIVE VIRUS VACCINES FOR CATTLE

Robert F. Kahrs, DVM and Robert B. Hillman, DVM

INTRODUCTION

Efforts to reduce losses from bovine viral infections have largely relied on modified live virus (MLV) vaccines. Vaccines released for distribution must be potent, pure, safe and efficacious. Purity and potency can usually be evaluated in vitro, but safety and efficacy must be determined in animals.

Vaccination-challenge studies in isolation determine the resistance of vaccinated cattle to standard challenge and also provide data on vaccine safety. Vaccination-challenge studies are essential to vaccine development, but do not satisfy the need to know a product works at the farm, ranch or feedlot. This "need to know" can be fulfilled only by carefully designed field trials. Field trials must be interpreted with caution because of the possible influence of multiple uncontrolled variables and bias.

Vaccine field trials can answer questions of both safety and efficacy. Direct safety data is easily obtainable, but it is difficult to assess possible indirect effects of vaccination.

Development of clinical efficacy data from field trials is frustrating because the investigator must await natural exposure and appearance of clearly definable disease. Natural exposure depends on chance, and its likelihood will be reduced if a portion of a population is immune.

Even if natural exposure occurs, there is little likelihood of diagnosed clinical disease sufficient to compare vaccinates with controls because bovine viral diseases are difficult to diagnose and viral infections are frequently inapparent with clinical signs requiring special host-agent-environment interactions and appropriate complicating factors. Therefore, seroconversion is frequently used as an indicator of vaccine efficacy.

Technologic advances in virology and immunology are confirming earlier suspicions that (for some viruses) seroconversion per se may not be a reliable indicator of vaccine efficacy. Total reliance upon seroconversion ignores the value of secretory antibody and overlooks the limitations of humoral antibody in preventing infections. Some cattle with specific serum antibody to some viruses can be infected and some cattle without detectable serum antibody have a specific immunologic mechanism for resisting infection. However, the lack of seroconversion in cattle vaccinated with a product which normally induces humoral antibody indicates a lack of vaccine potency or im-
proper administration. Traditionally, cattle found to have serum anti-
body when vaccinated are considered unsuitable test animals.

Each of these concerns must be addressed in designing field trials
and establishing parameters for measuring safety and efficacy.

DESIGN OF FIELD TRIALS

Stating the Objectives

The objectives stated must be more specific than: "to determine if
a vaccine is safe and effective for cattle". Each criterion evaluated
must be defined and the method of measurement stated. It must be
decided if vaccinates are to be compared to controls or to some other
predetermined standard with respect to each parameter.

Limiting Bias

Bias is error in observation or interpretation with consistent
inclusion in one direction. Bias can be introduced unconsciously by
observers who are eager for success. It is best limited by clearly de-
fining parameters and having them measured by an observer who
doesn't know which cattle received the test vaccine. This is acco-
 mplished in double blind trials in which neither the caretaker nor the
observer knows which animals received which treatment. Each test
vaccine or placebo must be identical in appearance and coded. The
observer should not be present at vaccination. The code should be
broken only if untoward reactions occur and treatment is contingent
knowing the contents.

In double blind studies, assignment of treatment must be a truly
random procedure. This means every animal in the study population
must have an equal and independent chance of receiving each treat-
ment. This is best done after the animal is restrained and identified
by flip of a fair coin or a dice toss. Vaccinating the more easily re-
strained cattle or the first group caught does not constitute random
assignment. The theoretical ideal of random assignment frequently
breaks down under practical logistical considerations. In one MLV
vaccine trial pregnant cattle all received placebo regardless of the
outcome of the coin toss. Such breakdown in randomization can in-
roduce a whole series of biases.

With intranasal or oral vaccines which are shed from vaccinates
and may be spread to unvaccinated contact controls, random assign-
ment cannot be utilized. Having controls in another barn or pasture
exposes them to entirely different environments and introduces mul-
tiple variables which complicate and obscure interpretation. In a field
trial of an intranasal MLV vaccine for infectious bovine rhinotrache-
itis (IBR) and bovine myxovirus parainfluenza-3 (BPI-3), we flipped
a coin to choose which roomful of veal calves would receive vaccine.
When mortality from apparently unrelated causes was higher in the room containing vaccinated calves than it was in the room receiving placebo, we were at a loss to ascribe the problem to anything but chance. Nevertheless, we couldn’t help wondering if MLV vaccine in some way predisposed calves to subsequent demise from salmonellosis and pasteurellosis.

The comparison of vaccinated cattle on one farm with unvaccinated on another farm or comparison of animals vaccinated in one year with unvaccinated cattle from a previous year, introduce so much uncontrolled variation that such procedures are unacceptable.

Evaluating Vaccine Safety

The safe vaccine produces minimal undesirable reactions. The duration after vaccination during which daily safety observations are made should be indicated at the outset. This interval must be 2-3 times the mean incubation time of the natural disease. However, in bovine viral diseases, incubation periods are not always known, and “crude incubation times” recorded under field conditions do not always agree with experimentally recorded incubation periods.

In the above mentioned field trial in assembled newborn calves, we arbitrarily set the post-vaccination period for direct safety observation period at 7 days. Since sickness and death during that interval was minimal and essentially equal in vaccinated and placebo inoculated calves, and because no disease attributable to vaccine was observed, we concluded that vaccine safety was demonstrated. Subsequent mortality due to salmonellosis was substantially higher in vaccinated groups and one hypothesis generated by these data was that MLV vaccination may have indirectly contributed to the eventual demise of some calves. Hypotheses suggested by data, cannot be tested using the data which generated them. So a new experiment should be designed with deliberate effort to control pertinent variables and evaluate a slightly different set of parameters. In this new study the initial hypothesis must include opportunity for the alternate hypothesis, (i.e. that vaccination reduces salmonellosis mortality) to be expressed.

When no controls can be used, some safety parameters can be evaluated by comparison with an initially established standard. It is legitimate to state that a vaccine will be rejected as unsafe if greater than .01% of vaccinated cattle suffer anaphylaxis or if greater than 3% of pregnant cattle experience abortion within 100 days of vaccination. Designs involving abortion as a parameter usually include provision for attempting to ascertain the etiology of abortions within the observation period. Unless another etiology is evident, the abortion must be attributed to the vaccine. The difficulties in diagnosing abortion accentuates the need for placebo inoculated controls in field trials involving pregnant cattle. This need would become
particularly evident if an abortion storm occurred among pregnant vaccinates and no unvaccinated controls were available because a "shed and spread" vaccine made contact controls unfeasible.

**Evaluating Vaccine Efficacy**

The improbability of natural infection in trial herds, the difficulty in attaining a positive etiologic diagnosis and the limiting effect of successful vaccination on the development of a "hot epizootic" in the trial animals have been discussed earlier. If vaccination-challenge studies provide convincing evidence that vaccinated cattle resist challenge, and if an immunologic test of adequate sensitivity and specificity can be shown to be an indicator of resistance to challenge, then further efficacy determinations can be made in field testing without dependence on natural challenge. If seroconversion is judged an appropriate test of field vaccine efficacy then natural challenge actually becomes undesirable because it could cause seroconversion without disease in unvaccinated contact herdmate controls.

Any seroconversion without clinical signs among controls creates a problem. This can be regarded as evidence of vaccine spread or natural inapparent infection. Usually, there is no good basis for deciding which. If a prior assumption of "no spread" is accepted, then it is logical to assume natural inapparent infection is the cause of any seroconversion among controls. However, when controls seroconvert, some seroconversion among vaccinated cattle must also be attributed to natural inapparent infection. A simple formula for determining seroconversion attributable to vaccine is as follows:

\[
\text{Proportion Seroconversion Attributable to Vaccine} = \frac{\text{Proportion Seroconversion (Vaccinates)} - \text{Proportion Seroconversion (Controls)}}{1 - \text{Proportion Seroconversion (Controls)}}
\]

Since serologic test results vary depending on technique and quality of reagents, serologic criteria for efficacy must be determined in advance with every detail of the test procedure specified. In evaluation of seroconversion to IBR vaccines we sometimes get different results using different antigens.

**CONCLUSION**

There are serious limitations on the quality and quantity of information which can be obtained from field trials of bovine MLV vaccines. Nevertheless, such trials are essential to understanding a vaccine, and if properly designed and executed, they can produce information which cannot be gained in any other way.

In order for field trials to have credibility comparable to other types of research, efforts must be made to increase their sophistica-
tion. This can be done by anticipating inevitable problems and working to minimize them.

It must be decided if safety determinations will be limited to immediate post-vaccination period or if prolonged observations for delayed sequelae are necessary.

It must also be decided if vaccinated and control animals are to be compared with respect to the incidence of non-specific disease syndromes. If higher incidence of such syndromes among vaccinated cattle are to be attributable to an indirect predisposing effect of the vaccine, then a lower incidence among vaccinated cattle must be evaluated as an indirect beneficial effect.

The unlikelihood of clear-cut natural challenge and the difficulty in diagnosing bovine viral diseases limit the chances that the efficacy of the product will be really tested. Therefore, it must be decided if seroconversion or other immunologic test can be regarded as an adequate indicator of immunity. If seroconversion is judged adequate, it must be defined in terms of the test, the antigen, the magnitude of the serologic response required, and the disposition of cattle with pre-existing humoral antibody. The effect of seroconversion due to natural infection must be evaluated by comparing seroconversion rates among controls with those of vaccinated cattle.

The quality of MLV vaccines for cattle and the credibility of field data could be improved if post-doctoral training programs were available for persons participating in the design, implementation and evaluation of vaccine field trials.

REFERENCES

REPORT OF THE COMMITTEE ON BIOLOGICS

Chairman: Richard F. Hall, Caldwell, ID
Co-Chairman: James W. Glosser, Helena, MT


Twelve members of the U. S. Animal Health Association Biologics Committee and 20 others were present at the Committee meeting. The chief concern of the Committee remains the availability of “Low Volume” biologics for the animal industry. During the past year producer organizations, veterinary groups, and agencies within the U. S. Department of Agriculture have been formulating possible actions to alleviate this situation. Reports were heard explaining these efforts.

Mr. Burton Eller, Associate Director, American National Cattlemen’s Association, emphasized the importance and necessity for all segments of the livestock industry to join together for a unified approach in solving the problem. Dr. R. A. Gessert, Chairman, USAHA Committee on Pharmaceuticals and Toxicology, reviewed the Committee’s discussion concerning low volume biologics and minor use drugs. Mr. John C. Morrison, Managing Director, Sheep Industry Development Program, Inc., informed the Biologics Committee through letter of the sheep industry’s need of low volume health care products.

Dr. John E. Spaulding, Chief Staff Officer, Scientific Services, Meat and Poultry Inspection Programs, APHIS, addressed the Committee with a proposal for the registration of minor use drugs and biologics. Dr. Spaulding proposed that a very important phase of the project is to hold meetings where representatives of the drug and biologic industry (AHI Task Group on Minor Users), the FDA and USDA can meet and discuss the problem inherent in implementing a program where special consideration can be given to minor use biologics and drugs. A proposal for initiating this program has been drafted and will be forwarded in the near future to the Subcommittee on Biologics for comments and consideration.

The Subcommittee on Biological Products with Low Sales Potential prepared a situation report. (See attachment #1). This was distributed to the House Committee on Agriculture, the Senate Committee on Agriculture and Forestry, Deans of Colleges of Veterinary Medicine, Department Heads of Veterinary Science Departments, Directors of Agricultural Experiment Stations, and other interested parties.

*Indicates members present.
The subcommittee was reappointed to continue the effort to resolve these problems. Attention will be directed toward the further identification of specific products required, determination of priorities, and the initiation of specific cooperative action to make the products available to the livestock producer. Information relating to these needs should be forwarded to this subcommittee. Members are J. W. Glosser, L. E. Hanson, D. A. Fuller, G. V. Peacock, Skip Thayer, and R. F. Hall.

The Committee continues to express concern over the manufacture and distribution of biologics within states that do not meet federal requirements. Due to the urgency of this problem a resolution has been submitted urging amendment of federal and state laws to correct this situation.

REPORT OF THE SUBCOMMITTEE ON VETERINARY BIOLOGICS ON DEVELOPMENT AND PRODUCTION OF VETERINARY BIOLOGICAL PRODUCTS WITH LOW SALES POTENTIAL

Part I—Introduction

The United States Animal Health Association's standing committee for Biologics has been greatly concerned for the past three years over the disappearance of a number of so-called "low volume biologics." These are defined as current licensed biologics which for economic and/or technical reasons are no longer feasible to manufacture, and potential biologics which have not been made available because of low volume use and/or high costs of development. All of these biologics are or have the potential of being essential to animal health and in some instances, important to human health as well.

Due to limited sales potential and the high costs of meeting the USDA license requirements, commercially licensed manufacturers cannot economically justify the development, and in some instances the production, of several badly needed low volume biological products. The net effect is that livestock producers will either not use the high cost biologics or will be forced to seek non-licensed private laboratories for production of limited supplies of these products. Most of these unlicensed products needed by livestock producers would be produced without the necessary safety and efficacy requirements to protect the consumer resulting in products of questionable quality to fulfill demands.

PART II—Species of Animals Affected by The Non-Availability of Biologics

Animal species in the United States affected by this problem include but are not limited to the following: sheep, goats, poultry (specifically the commercial duck industry), pet birds, fish and
aquatic animals, and horses. Recent social pattern and life style changes have resulted in an increase in the numbers of certain species such as goats and horses. In contrast, the sheep industry is in dire stress and diminishing, due to increased predation, high labor costs, and other economic factors which have forced many sheep owners to temporarily or permanently cease the sheep production business.

Another consideration is certain cattle diseases which are of low incidence or limited geographic distribution and would result in low volume products.

PART III—Biological Products Involved

A. CURRENT PRODUCTS

1. Bluetongue Vaccine
   Bluetongue vaccine is currently available. However, recent research in the United States has demonstrated the existence of several viral strains which differ from the strains presently used in the current product. Since cross-immunity does not exist between bluetongue strains, polyvalent vaccines are severely needed to fully protect susceptible sheep and cattle. The current vaccine is not recommended for cattle. Further, the U. S. Sheep and cattle industries encounter difficulty in exporting animals to countries which require bluetongue vaccination. Presently animals cleared for export are incompletely protected against all of the recognized strains of bluetongue. Current research is conducted primarily by Agricultural Research Service facilities. Private biological producers do not find it economically feasible to conduct the research necessary to develop improved bluetongue vaccines.

2. Contagious Ecthyma Vaccine
   Contagious Ecthyma vaccine is a very essential biological product for minimizing large economic losses in the sheep industry. The vaccine may no longer be available because of low sales potential.

3. Ram Epididymitis Bacterin
   Ram Epididymitis bacterin is a highly important vaccine for those sheepmen who raise breeding rams for sale. This product is no longer available commercially.

4. Equine Leptospirosis Bacterin
   With an increase in the equine population, the incidence of this disease is increasing. Current leptospiral bacterins are not cleared for use in this species, since the necessary research has not been conducted to determine efficacy of the currently available bacterins for horses.
B. SOME NEW PRODUCTS FOR WHICH DEVELOPMENT IS NEEDED

1. Enzootic Viral Abortion Sheep and Cattle.
2. Epizootic Bovine Abortion.
3. Pox Virus Vaccine for Canaries.
4. Duck Enteritis Vaccine.
5. Duck Hepatitis Vaccine.
6. Rabies Vaccine for Pet and Zoo Animals (other than dogs and cats).
7. Newcastle Disease Vaccine for Avian Species (other than chickens and turkeys).
8. Biological products for laboratory animals and commercially raised fish.

PART IV—Impact

With the absence of biologics for these diseases, certain livestock industries are further endangered. Sheep numbers are sharply declining, and the lack of commonly used protective vaccines will hasten the decline. Without essential biological products this industry may be virtually eliminated. The duck game bird industry and segments of the fish industry may also be endangered without biologics.

The lack of low volume biologics could result in an increase in disease transmission from animals to man. For example, Sore Mouth (Contagious Ecthyma) of sheep results in Orf in humans. Also, Leptospirosis may be transmitted from horses to humans.

PART V—Recommendations

Research is needed for the development of biologics for the control of livestock and poultry diseases in areas of low industry demand. Although certain livestock groups have relatively low populations, the scientific community must provide research support to protect these components of the industry. Their over-all importance to the United States and the world for food production often is more significant than the current economic value indicates.

Federal and state scientific communities, including the university sector, must assume responsibility in providing the necessary support. It is necessary that the various research needs be identified and priorities be determined for action. In some cases where livestock populations are regionally located, regional research emphasis should be considered.

As the development and/or production of low volume products by
the biologics industry is often not economically feasible, special grants may be necessary for product development and production. The establishment of general guidelines for product development would reduce economic pressure on individual biologic development. Co-operative and coordinated efforts to develop such products would reduce unnecessary repetition. A comprehensive review of foreign literature should be conducted to determine appropriate foreign products applicable to U.S. diseases. The products should be evaluated for efficacy and safety, and then made available when appropriate to the U.S. livestock industry.

Financial support might be obtained in the form of special grants from the appropriate livestock groups or from state and federal agencies to provide biologic production in special cases where commercial sales would be inadequate to support development and production.

Another approach is to seek relief in the efficacy and safety requirements presently required by the USDA. For example, licensed biologics known to be safe in one or more species could be recommended for another species with only limited data for that species. Likewise, efficacy data could be extrapolated to a similar species based on scientific judgment. Field data and experience should be considered as support for both efficacy and safety in lieu of long-term research trials. In addition, the rigid requirements for a serial-by-serial potency test correlated with statistically valid research data in the target species should be modified and indirect tests accepted. The statement "no U.S. standard of potency" should continue to appear on the label, if appropriate.

The committee views this alternative approach as a compromise and a step backward in providing the livestock industries with quality biologics in protecting their animals from disease.

PART VI—Conclusion

To safeguard threatened animal groups important to the health and economy of this country, positive steps must be taken. Although the committee views the last recommendation as a compromise and a step backward in providing the livestock industries with quality biologics in protecting their animals from disease, it does recognize that such a compromise would be better than the emergence of the "bathtub gin" biologics that will flood the market in the future, or the loss of products needed to maintain so-called "minority" animal populations.

Moreover, the committee recognizes the need to alert all responsible parties to the serious economic impact that the lack of so-called "low volume" biologics has on certain important livestock populations, and the committee is available to further define these issues.
FAILURE OF ANAPLASMA MARGINALE THEILER TO SURVIVE NATURAL WINTER CONDITIONS ON A DERMACENTOR ANDERSONI = (VENUSTUS) INFESTED RANGE

K. J. Peterson, DVM; R. L. Goulding, PhD; H. T. Turner, PhD

INTRODUCTION

Bovine anaplasmosis is enzootic in the semi-arid sagebrush-bunchgrass area of eastern and central Oregon where the Rocky Mountain wood tick (Dermacentor andersoni) = (venustus) is the major Anaplasma marginale Stiles vector (7, 9). This is a hardy northern three host tick which is resistant to severe cold and is found in the Rocky Mountain and Intermountain regions of the United States at elevations of 500 to 9000 feet (0.152 km to 2.74 km). Small mammals serve as hosts of the larvae and nymphs while adults require large mammals, preferably cattle and horses, to complete their development (3, 6). All stages are hematophagous and must ingest a blood meal to survive. The life span of the tick is 2 to 6 years.

It has been suggested that transovarian and transstadial transmission of A. marginale occurs in D. andersoni and that under favorable conditions the organism may be picked up and transferred to all succeeding stages of the tick for at least 2 generations and still be capable of infecting susceptible cattle (6, 13). Ricketts demonstrated that the etiologic agent of Rocky Mountain Spotted Fever (Rickettsia rickettsii) was transmitted transovarially and transstadially by D. andersoni (3). Howell demonstrated transovarian transmission of A. marginale by D. andersoni in a single experiment (4). However, numerous similar trials by other researchers failed (1, 11, 12). These trials were not conducted in a D. andersoni indigenous area and altered environmental conditions may have influenced the results. Whether transovarian transmission occurs in nature, and if so, to what extent, is presently not known.

Transstadial transmission has been demonstrated in the laboratory (1, 2, 10) but this type of transmission should be of little significance since under natural conditions the larvae and nymphs parasitize small mammals rather than larger ruminants (3, 6). To date, no species of small mammals has been incriminated as a reservoir host of A. marginale.

Since under natural conditions transovarian and transstadial
transmission appear to be of no significance, adult *D. andersoni* by repeat feeding must act as the vector of *A. marginale*. Repeat feeding of adult females is unlikely as females quickly attach to the host, begin feeding and usually remain attached until replete. Following engorgement and fertilization 14 to 17 days after attachment they drop from the host and seek a sheltered place for oviposition which may begin in 3 to 5 days (6). Following oviposition the female dies. Repeat feeding by males does occur as they move about the host seeking females (6). As suggested by Roseboom et. al. (11) at this stage the males may leave the host and later parasitize another. Since *D. andersoni* is a biological vector, infected male ticks may transmit *A. marginale* for a considerable period of time. It has been demonstrated in the laboratory that *A. marginale* will remain alive in the adult male tick under partial hibernating conditions for as long as 197 days (1). If it is capable of remaining alive and viable under natural conditions throughout the entire winter dormant period of the tick, control will be difficult since pastures will remain infected from year to year.

To determine whether under natural conditions *A. marginale* survives the long winter dormant period of *D. andersoni* a two year study was conducted on the Squaw Butte Experiment Station. This station located in the anaplasmosis enzootic area of Eastern Oregon, consists of two ranches, the Squaw Butte Range of 16,000 acres (6,475 ha) situated in the semi-arid sagebrush-bunchgrass area and the winter headquarters ranch of 640 acres (259 ha) located 40 miles (64 km) distant on a flood plain meadow. *Dermacentor andersoni* have not been found on the headquarters ranch although numerous collection attempts by flagging and CO₂ trapping have been made. Undoubtedly the tick is continually introduced into this meadow habitat on both domestic and wild animals. Apparently the habitat will not support *D. andersoni* populations. The tick is indigenous to the Squaw Butte Range.

A herd of approximately 600 Hereford cattle is maintained by the station. Most of the animals are grazed from the latter part of April until October on the Squaw Butte Range. All are wintered at the headquarters ranch. Numerous Anaplasmosis Card Agglutination Tests (CT) and Standard Complement-fixation Tests (CF) conducted on this herd during the past 4 years have demonstrated that approximately 70% of adults are latent *A. marginale* carriers.

**MATERIALS AND METHODS**

1975 Trial—On April 29, 1975, 35 Holstein-Friesian steers (principals) 7 to 9 months of age were trucked to the Squaw Butte Range and unloaded directly on a double fenced sagebrush-bunchgrass pasture which had contained no cattle since October, 1974. The principals were purchased from a large dairy located in the Willamette Valley of Oregon where anaplasmosis is seldom observed. On March 18 and
April 28 prior to purchase a 5 ml blood sample was collected from each in a vacutainer containing no anticoagulant. After clotting, the samples were refrigerated at 4°C. The CT following the method of Hynson, Wescott and Dunning* was conducted on the serums 72 hours following collection. All tests were negative.

These anaplasmosis free principals grazed the entire season until October 3 on 5 double fenced sagebrush-bunchgrass pastures totalling 1,200 acres (486 ha). These pastures had been grazed the previous summer and for years prior to that by the Squaw Butte herd. To avoid direct contact with the latent A. marginale infected herd, each pasture grazed by the principals was double fenced. An area 15 to 40 feet (4.6 m to 12.2 m) wide separated the fences. A portable corral and chute were used for examining the principals and collecting blood samples. The principals were observed daily for signs of illness and at 2 week intervals 10 ml of blood was collected from each, 5 ml in a vacutainer containing EDTA and 5 ml containing no anticoagulant. A sterile disposable needle was used on each animal and nose-tongs were disinfected between animals. All surgical procedures were performed using aseptic techniques. On collection day, packed cell volume percent (PCV) and hemoglobin (Hb) values (gm/100 ml as measured by the Spencer Hb. Meter)b were determined for each sample. Blood smears were stained by modified Wright's method and later examined for A. marginale bodies by light microscopy. Serums were refrigerated at 4°C and later tested by the CT method. Positive control serum was collected for each series of tests from a latent infected steer maintained at Oregon State University, Corvallis, Oregon.

On April 23, blood was collected from thirty, 6 to 8 months old Squaw Butte fall-born Hereford calves in the same manner as from the principals. Serums were tested by the CT method and all were negative. On April 28, these calves (controls) with their dams and the main herd were trucked to the Squaw Butte Range. During the grazing season they grazed pastures surrounding those containing the principals. There was no observable difference in these pastures regarding vegetation, animal life or topography. Serum samples were collected from the controls on September 4 and October 8 and the CT conducted on September 7 and October 13 respectively. As with the principals, nose-tongs were disinfected between each control and a sterile disposable needle was used on each. All necessary surgical procedures were performed with aseptic techniques. No insecticides or acaricides were used on either the principals or controls. The controls were weaned on September 4 and 25 were moved to a feedlot on the headquarters ranch and 5 to a feedlot at Corvallis, Oregon. The final tests were conducted on both controls and principals on October 13.

*aAnaplasmosis Card Test, Hynson, Wescott, and Dunning, Inc., Baltimore, Md.
bSpencer hemoglobin meter, American Optical Corp., Buffalo, New York 14215.
On June 26, July 23, August 5 and September 3 the principals were examined in a squeeze chute for the presence of *D. andersoni* by digital palpation and visual observation. Tick numbers were recorded and ticks classified as either flat or engorged. No ticks were removed or detached.

**1976 Trial**—Eighteen purebred Red Polled females varying in ages from 1 to 10 years were shipped from the Willamette Valley to the Squaw Butte headquarters ranch during February. Blood samples were collected from each on February 26 and the serums were tested for anaplasmosis by both the CT method and CF test on March 4. All tests were negative. On April 23 serum samples were again collected. All CTs were negative and on April 26 the cattle were trucked to the Squaw Butte Range where they were unloaded on a double fenced pasture grazed in 1975 by the main herd. Ten of the Red Polled cows were nursing spring born calves.

On April 28, blood samples were collected from 8 aged Hereford non-pregnant cows at the Eastern Oregon Agricultural Research Center located at Union, Oregon. This center is located in an area where anaplasmosis is not enzootic and a previous 1975 herd test indicated no latent *A. marginale* carriers. The CT conducted on the serums of the 8 Herefords were negative. The cows were trucked to the Squaw Butte Range on May 4 and were unloaded on the pasture containing the Red Polled cattle. This anaplasmosis free herd of 26 head was maintained as the experimental herd (principals) and was handled and tested in an identical manner to the 1975 principals except that blood collections and tick examinations were made at 3 week intervals and tick examination began on May 20.

Throughout the summer pasture season the principals grazed 2 double fenced pastures totaling 1640 acres (663.7 ha) all of which had been pastured the previous summer by the 1975 controls, their dams and the main herd. The spring born Red Polled calves remained with their dams, throughout the summer. They were tested by the CT method only at the trial's termination when they were weaned.

On April 29, 30 fall born Hereford CT negative calves (controls) were moved from the headquarters ranch along with their dams and the main herd to the Squaw Butte Range. Here they were maintained during the summer grazing period on *D. andersoni* infested pastures similar to those grazed by the principals. Serum from each control was collected on May 10, July 12, August 4 and October 19 and tested by the CT method. These controls were otherwise handled in the same manner as those in the 1975 trial.

**Results**

1975 trial—No signs of illness were noted in the principals during the daily observation periods. The CTs remained negative during the
entire trial, no *A. marginale* bodies were observed in the stained blood smears and PCVs and Hb. values (Table 1) remained within normal ranges.

The control calves were not observed daily since they grazed with the main herd over a large area. However, when observed, none demonstrated clinical signs of anaplasmosis. Thirteen controls developed positive CT reactions by September 4 and 18 of 30 (60%) by October 8 (Table 5).

*Dermacentor andersoni* counts conducted upon the principals demonstrated that tick activity decreased after July 1, but a few ticks persisted into August and 1 into September (Table 3).

1976 trial—The principals remained clinically healthy during the entire trial as no signs of anaplasmosis or other illness were noted during the daily observation periods. The CTs again remained negative, no *A. marginale* bodies were observed in stained blood smears. None of the PCVs and Hb. values were reduced—generally they were slightly higher than normal possibly due to dehydration resulting from heat stress (Table 2). Serum from the ten spring calves were also CT negative when tested at the trials termination.

The control calves were not observed daily. However, none were observed ill during the grazing season and all appeared healthy when weaned and removed from this range on August 4. Seven of the 30 controls (23%) developed positive CT reactions by October 21 (Table 6). Four were CT positive on July 12, another developed a positive CT reaction by August 4 and 2 more by October 21. All calves eliciting a positive reaction continued to react in succeeding tests.

*Dermacentor andersoni* counts (Table 4) as expected were highest during May but ticks were still active on July 22. None were observed on the August 2 count.

To avoid possible interference with *A. marginale* transmission, ticks were not removed during either the 1975 or 1976 counting procedure. An accurate sex determination of the ticks was therefore not possible. All engorged ticks were females but flat ticks may have been either males or engorging females which had recently infested the host.

Discussion

In both 1975 and 1976 trials the anaplasmosis-susceptible principals remained free of anaplasmosis throughout the summer grazing period which extended from late April or early May into October. During both periods, they grazed *D. andersoni* infested pastures which had been grazed the previous year by a herd of cattle heavily infected with anaplasmosis. In contrast, 60% of the 1975 and 23% of the 1976 control calves developed positive-CT reactions. They were main-
tained during the grazing periods on similar pastures but in direct contact with infected cattle. The high transmission rates observed in the controls likely resulted from male *D. andersoni* ingesting one or more blood meals from infected cows prior to parasitizing the susceptible controls.

Results of these trials demonstrated that *A. marginale* failed under natural range conditions to survive the winter season on *D. andersoni* infested pastures. It did not remain viable in either nymphs or adult ticks during their long dormant periods. Transovarian and transstadial transmission, if they occurred, were of no significance since *A. marginale* infection did not continue into the adult tick stage.

No species of small mammals was involved as an *A. marginale* reservoir host since identical species must have been present in the adjacent pastures grazed by the principals and controls. In 1976 the principals grazed the identical pastures grazed by the controls in 1975. Mule deer (*Odocoileus hemionus hemionus*) present on this range in moderate numbers were of no significance as reservoir hosts of *A. marginale*. It has been demonstrated in Idaho (5) but not in Oregon (8) that mule deer may act as natural reservoir hosts of *A. marginale*. Mule deer commingling on this range for years with a herd of heavily infected cattle failed to play a role in *A. marginale* transmission. Apparently *A. marginale* survives the winter season in this area only in latent infected cattle.

The higher infection rate in the 1975 controls (60%) compared to the 1976 controls (23%) cannot be explained. It is known that the incidence of bovine anaplasmosis differs from year to year in a given area. In previous experiments on this range infection rates in similar controls have varied from 40% to 63%. Whether the population of *D. andersoni*, the only proven *A. marginale* vector on this range (9) was greater in 1975 than in 1976 was not definitely determined. Tick counts were performed on the principals both years, however, in 1975 the first count was conducted on June 26, past the peak of the vector season. (The reason for counting the ticks was to determine when tick activity ceased). However, a comparison of this 1975 count with the July 1, 1976 count shows a greater number of ticks in 1976 (Tables 3-4). Assuming a similar tick population in the controls it would appear that the tick population in 1976 was at least as great as in 1975.

It has been stated that *D. andersoni* are not active after July 1 (3). However, *Dermacentor andersoni* activity in both the 1975 and 1976 trials extended into the latter part of July. In 1975, results suggest that the vector season in this area must be considered to extend from early spring through August. Finally the results of these two trials demonstrated that anaplasmosis could be controlled or eliminated on selected ranches in this area. Recommendations similar to those used
in the south and southeastern states for the development of anaplasmosis free herds would be applicable on ranches in central and eastern Oregon where the cattle are maintained separately and do not intermingle with other cattle of unknown status. These recommendations would be especially applicable to purebred herds where the owners wish to sell animals interstate and internationally. Cleaning up heavily infected herds at the present will be difficult and it probably is not advisable in herds that mingle with infected cattle. However, with the development of new, more effective, economical and more easily administered drugs, treatment to eliminate latent infected carriers from these herds may become practical.

SUMMARY

Anaplasma marginale did not survive the natural winter range conditions of eastern Oregon on D. andersoni infested pastures. Apparently the long dormant period of D. andersoni was lethal to A. marginale. Transovarian and transstadial transmission, if they occurred, were of no significance as infection did not continue into unfed adult ticks. No species of small mammal was involved in the transmission cycle since identical species must have been present in the adjacent pastures grazed by the principals and controls. Mule deer (Odocoileus hemionus hemionus) present on this range in moderate numbers were of no significance as A. marginale reservoir hosts. Apparently A. marginale survives the winter in this area only in infected cattle and is transmitted to susceptible cattle by D. andersoni parasitizing infected cattle and later during the same vector season parasitizing noninfected cattle. Results of these trials indicate that anaplasmosis could be eliminated in selected herds.
table 1. Packed Cell Volumes and Hemoglobin Values of the 1975 Principals - 35 Holstein-Friesian Steers

<table>
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<th>Date</th>
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<th>6/12</th>
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<td>PCV (%)</td>
<td>Mean</td>
<td>32</td>
<td>32.2</td>
<td>34</td>
<td>38</td>
<td>35.5</td>
<td>35.9</td>
<td>34.7</td>
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</tr>
<tr>
<td></td>
<td>Min.</td>
<td>26</td>
<td>24</td>
<td>30</td>
<td>32</td>
<td>31</td>
<td>30</td>
<td>28</td>
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<tr>
<td></td>
<td>Max.</td>
<td>40</td>
<td>38</td>
<td>39</td>
<td>45</td>
<td>46</td>
<td>42</td>
<td>41</td>
<td>40</td>
</tr>
<tr>
<td>Hb. (g/dl)</td>
<td>Mean</td>
<td>12.9</td>
<td>12.4</td>
<td>12.4</td>
<td>13.5</td>
<td>12.9</td>
<td>12.5</td>
<td>12.3</td>
<td>11.3</td>
</tr>
<tr>
<td></td>
<td>Min.</td>
<td>10.8</td>
<td>11.0</td>
<td>11.0</td>
<td>11.6</td>
<td>11.2</td>
<td>11.0</td>
<td>10.2</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Max.</td>
<td>14.4</td>
<td>14.4</td>
<td>14.5</td>
<td>15.0</td>
<td>15.0</td>
<td>14.6</td>
<td>14.2</td>
<td>13.8</td>
</tr>
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*Steers were 7 to 9 months old at the beginning of the trial.

Table 2. Packed Cell Volume and Hemoglobin Values of the 1976 Principals - 26 Red Polled and Hereford Females.

<table>
<thead>
<tr>
<th>Date</th>
<th>5/20</th>
<th>6/9</th>
<th>7/1</th>
<th>7/22</th>
<th>8/12</th>
<th>9/12</th>
<th>9/23</th>
<th>10/21</th>
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<tr>
<td>PCV (%)</td>
<td>Mean</td>
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<td>37.1</td>
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<td>41.2</td>
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<td>48.0</td>
<td>46.0</td>
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<tr>
<td>Hb. (g/dl)</td>
<td>Mean</td>
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<td>15.2</td>
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<td>Max.</td>
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</table>
Table 3. *Dermacentor andersoni* Observed Parasitizing 1975 Principals

<table>
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<tr>
<th>Date</th>
<th>6/26</th>
<th>7/23</th>
<th>8/5</th>
<th>9/3</th>
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<tr>
<td>Flat Ticks</td>
<td>23</td>
<td>20</td>
<td>3</td>
<td>1</td>
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<tr>
<td>Engorged Ticks</td>
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<td>0</td>
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<tr>
<td>Total</td>
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<td>32</td>
<td>6</td>
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<td>Mean/steer</td>
<td>3.1</td>
<td>.94</td>
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Table 4. *Dermacentor andersoni* Observed Parasitizing the 1976 Principals

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<th>Date</th>
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<th>7/22</th>
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<tr>
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<td>Engorged Ticks</td>
<td>328</td>
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<td>158</td>
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<td>Total</td>
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<td>Mean/Animal</td>
<td>23.3</td>
<td>10.5</td>
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Table 5. Anaplasmosis Card Agglutination Test Results of 30, 1975 Control Calves

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<td>865</td>
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</tr>
</tbody>
</table>

Total positive reactors | 0 | 13 | 18

NT=Not Tested
Table 6. Anaplasmosis Card Agglutination Test Results of 1976 Control Calves

<table>
<thead>
<tr>
<th>Calf No.</th>
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<th>8/4</th>
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<td>G 150</td>
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</table>

Total positive reactors 0 4 4 7

NT = Not Tested
REFERENCES


REPORT OF THE COMMITTEE ON ANAPLASMOSIS

Chairman: A. P. Schneider, Boise, ID
Co-Chairman: W. E. Brock, Stillwater, OK


The Anaplasmosis Committee met at 1:30 p.m. November 4, 1976 in the Americana Hotel, Miami, Fla. Nineteen persons were in attendance. The report of the committee in 1975 was read. The following reports were presented at this meeting.

Dr. K. J. Peterson reported on the continuation of research on the transmission of Anaplasmosis in eastern Oregon. Results from the past year confirm earlier work that there is no insect transmission of anaplasmosis to tick-free cattle in this area of Oregon. Dr. Peterson concludes that in eastern Oregon in the semi-arid sagebrush-bunchgrass area ticks are probably the only vector of anaplasmosis and that the infection does not winter over in the ticks. The species of tick in this area is Dermacentor andersoni. Dr. H. W. Renshaw presented a paper of his work in Idaho on determining the duration of immunity to anaplasmosis following antibiotic treatment.

Dr. E. J. Richey reported that he was able to cure the anaplasmosis carrier state with 0.5 mg. of clortetracycline per pound of body weight in the feed for 120 days. Reinfection of the cattle with anaplasmosis six weeks after treatment showed resistance to clinical anaplasmosis similar to vaccinated cattle.

Dr. J. C. Trace reported that the complement-fixation titers resulting from vaccination last much longer than were previously reported. Likewise, there is evidence that resistance to clinical anaplasmosis is longer after vaccination than earlier work showed. The incidence of neonatal isoerythrolysis continues to decline.

A. R. Schneider
William E. Brock
K. J. Peterson
A. A. Culbertson
E. E. Kerr
Harland W. Renshaw
IMMUNITY TO BOVINE ANAPLASMOSIS AFTER ELIMINATION OF THE CARRIER STATUS WITH OXYTETRACYCLINE HYDROCHLORIDE

Harland W. Renshaw, DVM, PhD; Robert A. Magonigle, MS; Willam P. Eckblad, MS; and Floyd W. Frank, DVM, PhD

INTRODUCTION

Anaplasmosis is an economically important, infectious, noncontagious, parasitic disease of cattle caused by the microorganism *Anaplasma marginale*.\(^1\) It has been estimated that in the United States anaplasmosis has an annual economic impact up to $100 million.\(^2\) Losses occur because the disease may cause decreased meat and milk production, reduced reproductive performance, and sometimes death of the infected animal.\(^1\) Clinically recovered animals remain carriers with a low degree of parasitemia and thus act as a reservoir of the disease.\(^3\) It is the carrier status, which poses the principal problem in control of the disease, because *A. marginale* can be transmitted from carrier to susceptible cattle by mechanical or biologic vectors.\(^4\)

A number of treatment and control methods, including preimmunization,\(^5-7\) blood transfusions,\(^8-11\) vaccination,\(^12-14\) and chemotherapy\(^15-28\) are available for anaplasmosis. At the present time the most widely used treatment regimen is the use of the broad spectrum tetracycline antibiotics. They can be used to treat the acute infection and eliminate the carrier status.\(^21\) In conjunction with the serum or plasma rapid card agglutination test, oral or parenterally administered tetracyclines have been used in "test and treatment" programs to determine the feasibility of eliminating the carrier status of *A. marginale* in cattle raised under various management situations.\(^5,15\)\(^24,29\) In general, successful treatment of cattle that are infected *A. marginale* carriers has been accomplished only after prolonged administration of large amounts of tetracyclines (orally, 2.2 mg/kg/day for 41 days, or parenterally, 11 mg/kg/day for 10 days).\(^23\) Recently, we have shown that oxytetracycline hydrochloride, an antibiotic approved for use in food animals by the US Food and Drug Administration (US FDA), when administered intravenously at the rate of 22 mg/kg/day for 5 days will render parasite-free adult cattle that are naturally infected *A. marginale* carriers.\(^30\)
Efforts directed at curtailing the spread of anaplasmosis have met with limited success, in part, because of limited producer support for programs designed to control and eventually eradicate anaplasmosis. Several factors which account for this lack of support of "test and treatment" programs are 1) expense and labor involved in supervision of the program, 2) interference with management practices caused by the program, and 3) an absence of information about the degree of immunity possessed by cattle after elimination of *A. marginale* by chemotherapy with antibiotics approved for use in food animals by the US FDA. Many cattle raisers believe that after *A. marginale* infected cattle have been rendered parasite-free by chemotherapy they are very susceptible to reexposure. In geographic areas where the risk of reexposure is considerable, this widespread general viewpoint acts as a strong deterrent to treatment of carrier animals in infected herds. However, evidence supporting this viewpoint is limited and, in fact, some data suggests that a degree of immunity persists after latent infections are eliminated by chemotherapy.

The purpose of the present study was to determine if some resistance (immunity) persists when adult cattle that were naturally infected *A. marginale* carriers were rendered parasite-free with parenterally administered oxytetracycline hydrochloride.

**MATERIALS AND METHODS**

Chemotherapeutic Treatment of Carrier Cattle—Eleven 2- to 3-year old Hereford cows that were naturally infected *A. marginale* carriers were purchased from a herd where anaplasmosis was enzootic. Reactor (carrier) status of each cow was determined by the standard complement-fixation (CF) test serum rapid card agglutination (SRCA) test, and inoculation of blood into susceptible non-splenectomized 8- to 12-month old Holstein-Friesian calves. Oxytetracycline hydrochloride (Liquamycin [50 mg/ml], Pfizer Inc., Terre Haute, Indiana) diluted 50% with sterilized physiologic saline was administered intravenously to each cow at the rate of 22 mg/kg daily for 5 days. After chemotherapy, the serums of all cattle were examined at intervals with the CF and SRCA tests for anaplasmosis reactor status. Carrier status was also determined 4, 12, 18, and 27 months after treatment by subinoculation of 10 ml of blood from each cow into anaplasmosis susceptible splenectomized 8- to 12-month old Holstein-Friesian calves. Experimental calves were obtained from the anaplasmosis-free dairy herd maintained at the University of Idaho. Before calves were subinoculated with blood from the treated cows, Wright's-stained blood films from the calves were examined to determine that parasitemia was not present, CF and SRCA tests were conducted to determine there was no serologic evidence of anaplasmosis, and microhematocrit values were determined.
to establish that the packed cell volume (PCV) was within the normal range. After calves were subinoculated with blood from the oxytetracycline treated cows, they were evaluated with microscopic exams of Wright’s-stained blood films, SRCA tests, and microhematocrit determinations twice weekly for 60 days. After the observation period the susceptibility of the calves was determined, after inoculation of 10 ml of blood from a known anaplasmosis carrier, by observing for hematologic, serologic, and clinical evidence of infection.

**Immune Status of Chemotherapeutically Treated Cattle**—Thirty months after the 11 cows had been rendered parasite-free with oxytetracycline hydrochloride an experiment was conducted to determine their clinical, hematologic, and serologic response to challenge exposure with *A. marginale*. The response of the 11 principals was compared to that of 4 Hereford cows, 4 to 5 years old, that had not been previously exposed to *A. marginale*. The control and principal cows were inoculated intramuscularly with 250 ml of heparinized (10 units/ml) blood from known anaplasmosis carriers. Each cow received 50 ml of blood from each of 5 different anaplasmosis carriers. After challenge the cattle were evaluated twice weekly through 35 days and weekly afterwards to 90 days with the SRCA test, microscopic examinations of Wright’s-stained blood films, and microhematocrit determinations.

**Carrier Status of Chemotherapeutically Treated, Challenge Exposed Cattle**—Ninety days after the 11 cows were challenge exposed, 250 ml of heparinized (10 units/ml) blood was transferred from each cow to an anaplasmosis susceptible splenectomized 8- to 12-month old Holstein-Friesian calf. After inoculation the calves were observed for clinical, hematologic, and serologic evidence of infection.

**RESULTS**

**Chemotherapeutic Treatment of Carrier Cattle**—The experimental data indicated that intravenous treatment with oxytetracycline hydrochloride at the rate of 22 mg/kg daily for 5 days could be used to eliminate carrier anaplasmosis infections in cattle (Table 1). By 4 months after treatment all cows became SRCA test-negative and they remained test-negative through 30 months. Splenectomized calves, which were inoculated with blood from the 11 cows at 4, 12, 18, and 27 months after chemotherapy did not develop anaplasmosis. Efficacy of the oxytetracycline hydrochloride treatment was confirmed when the subinoculated splenectomized calves that did not develop serologic, hematologic, or clinical evidence of infection with *A. marginale* during the observation period developed anaplasmosis after inoculation with blood from the known carrier. The calves developed clinical signs of acute anaplasmosis and a parasitemia, became SRCA test-positive, and the mean PCV decreased.
Immune Status of Chemotherapeutically Treated Cattle—The experimental evidence indicated that a degree of resistance (immunity) was present in the 11 cows that were challenge exposed to *A. marginale* 30 months after elimination of the latent infection by chemotherapy (Table 2). Whereas 3 of 4 control animals died of acute anaplasmosis (day 21, 23, and 29, respectively) only 1 of 11 principals (No. 3) showed any clinical signs of anaplasmosis. Signs in cow 3 were mild and of short duration, maximal parasitemia of 25% was evident at day 17 after challenge, and the PCV fell from a pre-exposure level of 41% to a low of 17% on day 17. The PCV fell in 9 of the other 10 experimentally challenged animals, but the decline in PCV was usually very transient and not clinically serious. The minimal PCV was 10% or below in each of the 4 control animals. Whereas the maximal anaplasma body count in the blood films of each control animal exceeded 3576, it did not exceed 6% in 10 of 11 principals. By day 14 after challenge 10 of 11 principals became SRCA test-positive and by day 28 the other animal became seropositive.

Carrier Status of Chemotherapeutically Treated, Challenge Exposed Cattle—By 35 days after inoculation each of the splenectomized calves that had been inoculated with 250 ml of blood from the challenge exposed cows developed acute anaplasmosis and 5 of 11 died (Table 2). Each calf developed a parasitemia and anemia; survivors became SRCA test-positive.

DISCUSSION

Experimental evidence obtained from this study indicates that a degree of resistance (immunity) persists in cattle that have had *A. marginale* infections terminated by chemotherapy with an antibiotic approved for use in food animals by the US FDA. In a previous investigation it was shown that immunity persisted after the treatment of latent infections of *A. marginale* with imidocarb dipropionate, an experimental drug. Evidence from our study, as well as several others, indicates that active immunity to bovine anaplasmosis is not dependent upon the continual presence of the agent in the animal. Since the interval between drug therapy and experimental challenge was 30 months it appears that long lasting immunity persists after *A. marginale* infections have been terminated with tetracycline antibiotics.

Blood from the treated cattle was noninfective when subinoculated into susceptible splenectomized calves 4, 12, 18, and 27 months after treatment. By 4 months after treatment all principals were SRCA test-negative. After challenge only 1 of 11 principals showed any clinical signs of anaplasmosis. Signs in this animal were mild and transient as compared to the clinical signs of acute anaplasmosis observed in the controls. The pathogenicity of the inoculum used to
challenge the treated principals was tested in 4 control animals and caused acute anaplasmosis in each and death of 3. After challenge each of the principals became SRCA test-positive and some developed transient hematologic changes. Furthermore, each principal became an *A. marginale* carrier, as determined by inoculation of blood into susceptible splenectomized calves. Each inoculated calf developed acute anaplasmosis.

There are a number of tetracycline treatment regimens that will effectively eliminate the *A. marginale* carrier status (see ref. 30) and can thus be used in "test and treatment" programs. Depending upon the specific management situation, a particular regimen may be advantageous. Although a certain proprietary product was employed in this study, other generic products of equal or greater concentration would probably have given similar results.

The SRCA test appears to be an accurate test for determining the success of treating carrier animals. We allowed 4 months between the time of treatment and the comparisons of the SRCA and calf inoculation tests in order to allow animals freed of infection to convert from seropositive to seronegative. At each of the test periods calf inoculation and SRCA test results correlated: seropositive animals were carriers and seronegative animals were not carriers when tested in susceptible splenectomized calves.

The results from this study imply that producers need not fear the use of a "test and treatment" program in herds where anaplasmosis is endemic and risk of reexposure to treated animals is considerable. A major reason that cattle raisers have been hesitant to utilize "test and treatment" programs is because of a widespread belief that once carriers of *A. marginale* are freed of infection by chemotherapy that they become very susceptible to *A. marginale* on reexposure. However, our data indicates that when naturally infected *A. marginale* carriers were freed of infection with oxytetracycline hydrochloride and challenge exposed with virulent *A. marginale* 30 months later, they were highly resistant to infections characterized by clinical signs of acute anaplasmosis. Thus, the duration of immunity following chemotherapy is prolonged and could be life long. In most geographic areas the primary source of infection for susceptible cattle is carrier animals in the same herd, with transmission occurring from carrier to susceptible by mechanical or biologic vectors. Removal of this reservoir of infection within a herd by a "test and treatment" program will reduce the risk of infection to susceptible animals. Our results indicate that even if the treated animal, which was freed of infection was reexposed, the risk of animal loss would be minimal, since it would not develop acute anaplasmosis.
SUMMARY

Intravenous administration of oxytetracycline hydrochloride at the rate of 22 mg/kg/day for 5 days terminated *Anaplasma marginale* infections in 11 naturally infected adult cattle. By 4 months after chemotherapy, results of the serum rapid card agglutination (SRCA) test were negative for all cattle. Thirty months after the 11 cows were rendered parasite-free with an antibiotic, approved for use in food animals by the US Food and Drug Administration, they were challenged with virulent *A. marginale* to determine their clinical, hematologic, and serologic response. The responses of the 11 principals were compared to that of 4 control cattle that had no previous experience with *A. marginale*. After challenge each of the 11 principals became SRCA test-positive, some developed transient hematologic changes, and 1 exhibited mild clinical signs of anaplasmosis; 3 of 4 control animals which were given the same challenge inoculum as the principals died of acute anaplasmosis. The results indicated that a degree of long lasting immunity to infections characterized by clinical signs of acute anaplasmosis persists in cattle that have been rendered free of latent infections of *A. marginale* by oxytetracycline hydrochloride chemotherapy. Each of the chemotherapy-treated, challenge-exposed cattle became *A. marginale* carriers. The relevance of these findings to the utilization of “test and treatment” programs by cattle raisers in endemic areas is discussed.
TABLE 1 — Effect of Oxytetracycline Hydrochloride, Administered Intravenously (22 mg/kg/day) for 5 Days, on the Carrier Status of Bovine Anaplasmosis, as Indicated by Serum Rapid Card Agglutination and Calf Inoculation Tests.

<table>
<thead>
<tr>
<th>Cow No.</th>
<th>Serum rapid card agglutination test*</th>
<th>Calf sub inoculation test results**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before treatment</td>
<td>Months after treatment</td>
</tr>
<tr>
<td></td>
<td>t</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>+</td>
<td>+</td>
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<tr>
<td>2</td>
<td>+</td>
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<tr>
<td>10</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>11</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

* SRCA test reactions are expressed as positive (+) or negative (-) agglutination.

** Calf sub inoculation test results are expressed as development (+) or absence (-) of anaplasmosis. All calves that failed to develop anaplasmosis were found to be susceptible when challenged with virulent A. marginale.
TABLE 2 — Response of Cattle Reexposed to *Anaplasma marginale* 30 Months After Elimination of Anaplasmosis Carrier Status by Oxytetracycline Hydrochloride.

<table>
<thead>
<tr>
<th>Cow No.</th>
<th>Before infection (%)</th>
<th>Minimal value noted after infection (%)</th>
<th>Day after infection when minimal value noted</th>
<th>Maximal parasitemia %</th>
<th>Day after infection when + serum rapid card agglutination test initially noted</th>
<th>Carrier status of cow exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39</td>
<td>38</td>
<td>21</td>
<td>&lt;1</td>
<td>21</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>38</td>
<td>32</td>
<td>14</td>
<td>&lt;1</td>
<td>21</td>
<td>10</td>
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<tr>
<td>3</td>
<td>41</td>
<td>17</td>
<td>17</td>
<td>25</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>36</td>
<td>36</td>
<td>--</td>
<td>&lt;1</td>
<td>14</td>
<td>10</td>
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<td>8</td>
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<td>34</td>
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<td>49</td>
<td>&lt;1</td>
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<td>28</td>
<td>21</td>
<td>6</td>
<td>21</td>
<td>28</td>
</tr>
</tbody>
</table>

Each cow was challenge exposed with virulent *A. marginale* and hematologic and serologic evaluations were made twice weekly through 35 days and then weekly to 90 days. Carrier status was determined 90 days after reexposure by inoculating 250 ml of blood into anaplasmosis susceptible splenectomized calves. + = positive carrier status.
IMMUNITY TO BOVINE ANAPLASMOSIS

REFERENCES


Mr. Chairman, Members of the Association, and Guests:

Although my name appears with that of Dr. Nicoletti in connection with this next report on the Efficacy of Adult Vaccination in some of our Florida problem dairy herds, I want to make it clear to you folks that I should not be given credit as being a co-author. Actually, my role in this project has been more or less that of a catalyst in the initiation and continuance of the work. It is in this capacity that I hope to put into proper perspective this morning the significance of Dr. Nicoletti's findings with relation to the eventual nationwide eradication of brucellosis.

First of all, though, I would like to express my appreciation to the Chairman of our Association's Brucellosis Committee, Dr. Bartelt, for permitting us to depart from the usual format in the order of presentation of material pertinent to the development of that committee's final report; not only in this formal scientific session this morning, but also in the deliberations of his committee this afternoon. As you are probably aware, papers relating to a given disease usually immediately precede the report of the committee involved with that particular subject. Further, the second session of the Brucellosis Committee meeting is normally reserved as an executive session so as to afford that group ample time to hammer out the details of those recommendations which are made in its report to this body. However, since the data to be presented now in this, the first scientific paper session, should answer many questions anticipated by committee members, it is felt that a great deal of time can be conserved by following this procedure, with but a minimal delay of the committee's executive session.

The request to institute these pilot studies was made to this organization at its meeting in St. Louis three years ago by a group of our Florida dairymen who had been unable to eliminate brucellosis from their herds using the conventional test and slaughter methods prescribed by the Uniform Methods and Rules. Following eventual approval in December of 1974 by the USAHA Brucellosis Committee to initiate limited trials, the project began with the first three problem dairies in the Summer of 1975, being augmented by the addition of two more dairies this year. As the title of this paper indicates, all of these herds have been inoculated with Strain 19 vaccine and, of course, Dr. Nicoletti will be discussing the details of the work at length. It is unfortunate, and there are many who share with me this opinion, that a comparative herd trial utilizing Strain 19 and 45/20

*Introductory remarks presented, by Dr. C. L. Campbell, State Veterinarian of Florida, November 9, 1976.
vaccines proposed over a year ago has not been authorized. Otherwise, at this time, we would have been in a position to have given you data on the efficacy of an additional vaccine, which information is sorely needed as we do battle with this disease. I am told that 45/20 is being put to test in the State of Texas currently, and I sincerely hope that the protocol by which it is being evaluated is sufficiently inclusive so as to be able to arrive at a determination of its worth without a further waste of time. I am sure that Dr. Nicoletti will be available this afternoon should committee members have further queries on this subject.

Notwithstanding the fact that insufficient time has elapsed with this project to provide all of the answers which we would like to have on adult vaccination, I am satisfied by the time Paul Nicoletti completes his discussion this morning and with committee members this afternoon, he will have demonstrated that we now have available to us an additional scientific procedure for incorporation in the Uniform Methods and Rules which will not only provide salvation to a near destitute segment of industry, but will do so without violence to the national effort. On the contrary, I am of the firm belief if we are to succeed in the eradication of brucellosis, we MUST institute all measures available to increase resistance to the disease, particularly in high incidence areas, concurrent with other long-range eradication plans now under consideration.

I sometimes feel that regulatory officials are often prone to become too dogmatic in their concepts and fail, as scientists, to fully explore sound alternative avenues in the realization of a goal. Of course, this statement is oftentimes as applicable to those who are regulated. Yet, I cannot believe that anyone here this morning is content to live with a disease as devastating as brucellosis can be to animals as well as to man, if that disease can be eradicated through a plan of practical approach which does not, in its application, decimate the beneficiary—in this case the cattle or dairy industry.

The inclusion of adult vaccination, coupled with other measures to be presented this afternoon, represents such an approach free from compromise to our down-the-road goal. Without some mid-course steering we will all be faced with a long up-hill battle.
The success of eliminating brucellosis is inversely related to herd size. In Florida the average dairy herd exceeds 400 and the percent of infected herds increases with total cattle numbers. Berman et al., concluded that large herds of dairy cattle frequently present a serious problem in establishing a successful brucellosis control program. They further stated that the difficulties are accentuated when it is necessary to replace infected animals from outside sources in order to maintain production.

Using computer models, Hugh-Jones et al., found a threshold of about 250 cows at which a significantly large and prohibitive proportion of reactors had to be removed, and a distinct probability that brucellosis could not be eradicated through test and slaughter methods.

Many reasons can be given for the difficulties of eliminating brucellosis in Florida dairy herds. Most replacements are imported and are likely to be unvaccinated as calves due to the decrease in Strain 19 usage in source areas. This has resulted in a shift in populations from largely vaccinated to largely unvaccinated. It is estimated that less than 25 percent of the dairy cattle in Florida herds have been vaccinated and 50 percent of the dairy cattle are in infected herds.

In May, 1975, studies were initiated to determine if adult cattle vaccination using Strain 19 by various methods could prove useful in eliminating brucellosis in selected herds. The effects of these inoculations were evaluated by five serologic tests and bacteriologic studies. Observations were made on establishment and persistence of Strain 19, possible losses of milk production, and abortifacient effects.

The vaccinal methods and doses which were studied included a standard 5 cc (S/C) and reduced dose (R/D) of 0.25 cc administered subcutaneously, 0.2 cc given intradermally (I/D), and a reduced dose administered by the conjunctival route (I/C).

MATERIALS AND METHODS

Blood samples were collected from all cattle in four experimental herds and from selected cattle in another. Five serologic tests were performed on all serums from the four herds and the card, rivanol, and complement-fixation test on serums from the selected cattle.
Serologic Studies

The standard tube agglutination test (STT) was performed using dilutions 1:50, 1:000, and 1:200. Cattle were classified according to Uniform Methods and Rules regardless of vaccinal method. The mercaptoethanol (ME) test was performed in the 1:25, 1:50, and 1:100 dilutions. Serum amounts of 0.08, 0.04, and 0.02 were added to three tubes and 1.0 ml of 0.1M solution of 2-mercaptoethanol and 1.0 ml of double-strength tube test antigen were added to each tube. Complete agglutination in the 1:25 or greater dilutions was considered positive test results. The card test was performed in the usual manner. Trace reactions were considered negative. The rivanol (Riv) test was performed by adding equal quantities (0.2 ml) of rivanol solution and test serum. The mixture was allowed to stand for at least five minutes and tubes centrifuged. The supernatant was tested in the 1:25 dilution by the plate method and, if positive, end point titers up to 1:200 were determined. Complete agglutination in the 1:25 dilution or greater was considered positive.

The complement fixation (CF) test was performed using modifications of the Kolmer technique. Commercial guinea-pig complement and antisheep hemolysin were used and titrated for optimal activity. Serum was diluted 1:10 in veronal buffer and inactivated at 56 to 58 C for 30 minutes. Inactivated serums were screened in the 1:10 dilution in U bottom microtiter plates. Serums with 50 percent (2+) or greater fixation were serially diluted in 1:10, 1:20, 1:40, and 1:80 dilutions by the microtiter technique. A 25 percent (1+) fixation in the 1:40 dilution or greater was considered positive in all serums regardless of source. No suspicious category was used.

Bacteriologic Studies

Quarter milk samples or secretion from the nonlactating udder were collected from selected cattle in sterile plastic bags. These were centrifuged at approximately 2000 g in 50 ml conical plastic tubes for 20 minutes. The centrifuged cream and sediment from each quarter were inoculated onto two culture plates and incubated for 5-7 days in a CO₂ atmosphere. One or both supramammary lymph nodes were collected from some cattle considered infected but whose milk cultures were negative. The tissues were homogenized using a VirTis apparatus. Aliquots were inoculated onto several culture plates. The medium was a tryptose base to which 20 ml bovine serum and 25,000 units of bacitracin/liter were added. Suspect Brucella colonies were generally typed by CO₂ requirement and growth on medium containing erythritol. Isolates were confirmed and further typed by the National Animal Disease Center, Ames, Iowa.

aCooke Laboratory Products, Alexandria, Virginia 22314.
**Efficacy of Adult Cattle Vaccination**

*Herd for Study*

Five large infected dairy herds were included in these studies.

Herd 1 consisted of approximately 900 adult cattle. The herd had been infected for many years and frequent tests and removal of card test reactors had failed to eliminate brucellosis. The cattle were tested in May, 1975, and card test reactors removed. The remaining cattle were vaccinated with a standard 5 cc dose of Strain 19 regardless of gestation or lactation status. The herd was retested at three month intervals. No cattle were removed at the first herd test because facilities for bacteriologic studies did not exist. Beginning with the six month post-vaccinal test, cattle considered to have brucellosis were sold for slaughter following bacteriologic studies. Observations were made on the effects of vaccination upon abortions, feed consumption, and milk production. Replacement cattle were vaccinated upon arrival with the same procedure.

Herd 2 consisted of approximately 400 cattle. The cattle were tested in May, 1975, and card test reactors removed. The balance of the herd was randomly selected so that half the cattle received a standard 5 cc dose of Strain 19 subcutaneously and half the cattle received 0.2 cc intradermally. The follow-up bacteriologic and serologic studies were the same as in herd 1. A group of 54 replacement cattle entered the herd in September, 1975. Those without evidence of calf vaccination (ear tattoo) were given a 5 cc dose of Strain 19 subcutaneously. Thirty-eight cattle with an ear tattoo were not re-vaccinated. No other replacement cattle were purchased until August, 1976. These were vaccinated as in the original procedure.

Herd 3 was approximately 8000 dairy cows. The herd had not been tested for several months and in June, 1975, the nonlactating cattle were tested and card test reactors sold. The high prevalence of card test positive cattle in this group caused the herd owners to refuse to test the balance of the herd (lactating cattle) and immediately sell the card test reactors. A decision was made to test the cattle at the end of lactation (weekly intervals) and vaccinate card test negative cattle with 5 cc of Strain 19. Reactors to the card test were sold. The vaccinated cattle were tested at the termination of the next lactation and cattle considered infected by results of rivanol and/or complement-fixation tests were sold for slaughter.

Herd 4 consisted of approximately 900 cows and had not been tested for several months. Frequent testing in previous years had failed to eliminate the disease. In November, 1975, the herd was tested and a large number of card test reactors removed. The balance of the herd was vaccinated by randomly selecting the cattle so that half received a 5 cc dose of Strain 19 subcutaneously and half received 0.25 cc (1/20th standard dose) subcutaneously. The testing frequency was three months after vaccination. Cattle considered to
be infected by serologic and bacteriologic examinations were sold for slaughter. Replacement cattle were vaccinated by the same procedure.

Herd 5 consisted of approximately 700 cows and had been tested frequently with the card test reactors removed. The infection persisted. In February, 1976, the herd was tested and card test reactors removed. The balance of the herd was randomly selected so that 40 percent of the cattle received 5 cc of Strain 19 subcutaneously, 40 percent received a 0.1 cc dose of Strain 19 in the conjunctival sac (adjusted to contain $5 \times 10^5$), and 20 percent were left as uninoculated controls. The cattle receiving the conjunctival sac inoculations were reinoculated at four months. Replacement cattle were treated by the same procedures and ratios. The herd retest schedule was two months and cattle considered to be infected with field strains of Brucella were sold for slaughter.

Cattle in herds 4 and 5 from which Strain 19 were isolated were generally left in the herds and repeated cultures made on the following herd tests.

RESULTS

Each of the five herds included in these studies was infected. Diagnosis of infected cattle following vaccination was complicated by seroagglutinins from Strain 19 inoculation, especially in cattle incubating the disease when vaccinated. Bacteriologic studies were critical in evaluations of seropositive cows.

Previous studies by this author had determined the efficacy of various standard and supplemental tests in detecting infected cattle in problem herds. The CF test had proven to be superior to others studied in correctly classifying culture positive cattle. Therefore, selection of cattle for cultures in these studies was based largely upon the least sensitive tests and greater probability of infection.

Table 1 summarizes the results of five serologic tests in a comparison of probable infection and post-vaccinal periods in herd 1. It was not possible to determine the number of infected cattle at three months post-vaccination since facilities for bacteriologic examinations were not yet developed. However, 22 of the 27 cattle considered to be infected on the six month post-vaccinal test were positive on all tests conducted three months post-vaccination. The card test was the most sensitive of all serologic procedures followed closely by the ME test.

A comparison of the serologic test results with the subcutaneous (S/C) and intradermal (I/D) vaccinal methods is made in Table 2. No bacteriologic studies could be conducted at the three month post-vaccinal test but 14 cattle of the 17 cattle considered infected on the six month test were positive three months earlier. Only one cow in the S/C group and none of the I/D group was considered infected.
after the six month post-vaccinal test. This cow yielded Strain 19 organisms and was vaccinated six months previously. She was serologically (CF and Riv tests) negative three months post-vaccination. There were considerable differences in the titers on the various tests following S/C and I/D inoculations.

A chronological history of herd 3 is given in Table 3. It is obvious that the prevalence of brucellosis was high in the dry herd and in the cattle tested when they completed lactation. The percentage of card test reactors increased as expected due to the increase in brucellosis in the untested and unvaccinated population. It is considered probable that most of the reactors on the Riv and CF tests are those incubating the disease when vaccinated. It is difficult to assess the efficacy of the vaccine under these conditions.

Table 4 summarizes the comparison of 5 cc (S/C) and 0.25 cc (R.D) doses of Strain 19 with the percentage of infected cattle and persistence of titers. There were little differences in the number of infected cattle in the two groups on the three month post-vaccinal test. It was considered that most of these cattle were incubating the disease when vaccinated. There were large differences in the percentage of cattle positive on most tests. A total of nine different cattle were culture positive for Strain 19 organisms. Four of these received the reduced dose. In no case was there a repeat isolation three or more months after the original isolation was made.

The groups of cattle in herd 5 are compared in Table 5. There were large differences between the subcutaneous (S/C) and conjunctival (I/C) inoculated groups in serologic findings.

The four herds (1, 2, 4, 5) in which periodic herd tests were conducted are included in Table 6. The vaccinal methods are compared within herds and with other cattle (calf vaccinates in herd 2; unvaccinated controls in herd 5). The pre-vaccination reactors per month (24 month average) and number of card test reactors when the cattle were vaccinated are shown. In herd 1 the average number of cattle sold as infected was reduced from 10.8 per month before vaccination to 2 per month six months after vaccination and one per month 15 months after vaccination. This represents an 80 to 90 percent reduction in cattle losses due to brucellosis.

There were no apparent differences in protection between the subcutaneous and intradermal inoculations in herd 2. Thirty-eight cattle entered the herd as calf vaccinated replacements and four of these were culture positive nine and 12 months later (Table 6). These were in contact with infected cattle for approximately three months in late 1975.

A total of 32 different cattle in the 5 cc S/C group in herd 4 were considered infected with field strains. This compares with 29
in the 0.25 cc R/D group. This suggests that there were no differences in protection between the two methods.

Twenty-one cattle in herd 5 were considered infected with field strains and which received the 5 cc dose S/C. This compares with 18 in the I/C group. The controls were 20 percent of the herd, or approximately half of each of the other two groups, and had 19 infected cattle. These results suggest there were no differences between the S/C and I/C groups in protection and a difference between these inoculated groups and the controls. No statistical analyses were made.

The small variations in total infected cattle in Tables 4 and 5 and those in the last two herds in Table 6 are due to repeated studies in some cattle later considered to be infected with field strains and with Strain 19.

The relationship of classification of cattle by five serologic tests and bacteriologic examinations is given in Table 7. The total cattle inoculated by various methods and uninoculated controls. The number considered probably infected is taken from Tables 1, 2, 4, and 5 and is based upon bacteriologic findings in cattle of similar serologic status. There were few tube test negative and no card or ME test negative cattle which were culture positive. The percentage of cattle positive on these tests and which yielded Brucella spp. is rather high but selection for culture attempts was biased by inclusion of mostly cattle whose serum was positive on Riv and/or CF tests. There were eight culture positive cattle whose serum had less than CF titers considered positive in these studies. All except one had fixation of three or four plus in the 1:20 dilution. Four of the eight cattle were Strain 19 culture positive. Cultures from cattle whose udder was infected with Strain 19 often recover very few organisms. Cunningham suggested the probability of a “udder barrier” to explain differences in indices of udder infection and other sites. Perhaps mild udder infections such as with Strain 19 sometimes fail to provide sufficient antigenic stimulation to produce high levels of complement-fixing and other antibodies in blood serum.

Attempts were made to observe the abortifacient effects of inoculating Strain 19 into cattle in various stages of pregnancy. Over 2000 cattle in four herds received a 5 cc dose. Many of these cattle were in advanced pregnancy (including replacements). Reported abortions following vaccination were almost nil. In herd 3 over 10,000 cattle were given the standard 5 cc dose at approximately 7-8 months of pregnancy and fewer than one percent aborted for any reason.

The number of Strain 19 infections in the udder following inoculation by the various routes was investigated by culturing large numbers of cattle with positive Riv and/or CF test reactions. Over 3000
cattle were inoculated by various routes in four herds in which extensive bacteriologic studies were conducted. There was a total of 21 different cows from which Strain 19 was recovered (Table 6). No isolations were made from the cattle which were inoculated intradermally. Most Strain 19 infected cattle were negative on subsequent culture attempts. The frequency and persistence of Strain 19 infections will continue to receive attention and results of these studies published.

The systemic effects produced by Strain 19 inoculations were recorded in herd 1 where all cattle were inoculated by the same method on two successive days. There was an average of 17 percent reduction in milk yield and a 15 percent reduction in feed consumption beginning two days after vaccination and for the following 10 days. The second and third days post-vaccination were the most severe when there was a 29 percent loss in milk production. There was a gradual return to normal production which was 12 days post-vaccination. The loss in milk production in herd 2 was less and averaged 12.5 percent for eight days post-vaccination.

**DISCUSSION**

It can be debated whether the efficacy of vaccines and methods of their administration can be evaluated under field conditions. The reduction of disease must be of greatest importance and the accompanying economics in sale of diseased cattle. When these are considered, these studies have shown effective results in large Florida dairy herds when compared with test and slaughter methods.

Many studies have shown effectiveness in vaccinating adult cattle under field conditions. Vaccination practically eliminates clinical disease and reduces exposure of infection to susceptible cattle. In the three herds (Table 6) in which vaccination of all cattle was performed, there was a reduction of diseased cattle of over 80 percent within nine months. In herd 5 there was a reduction of over 60 percent after six months in vaccinated cattle. The vaccination of cattle at the end of lactation (Table 3) is a much slower and less effective means of reducing the incidence of brucellosis and should not be recommended.

It is impossible to cite all the published studies on differential diagnostic procedures following Strain 19 administration. Test performance methods and classification of results are not standard. Most investigations were prior to the development of most supplemental tests and many studies have shown their superiority in classifying cattle with seroagglutinins. The CF test becomes negative sooner than agglutination tests following vaccination. In these studies the CF test was negative prior to the other tests regardless of vaccinal methods.

The CF test becomes negative sooner than agglutination tests following vaccination. In these studies the CF test was negative prior to the other tests regardless of vaccinal methods (Tables
1, 2, 4, and 5). The Riv test also became negative rapidly in a high percent of cattle, especially where reduced dosages were used. Worthington\textsuperscript{27} found that of 124 cows vaccinated during pregnancy, only four, 14, and seven were still positive to CF, ME, and Riv tests at six months post-vaccination. The STT, ME, and card tests in these studies were too sensitive and were not very useful in differentiation of infected cattle from those with post-vaccinal agglutinins. The criterion for classification of ME test positive cattle is too strict and consideration of a reduction of STT titers would make the test results more accurate. The card test is a useful screening procedure for serums in which less sensitive and more accurate tests should be performed. The STT has little practical value in the diagnosis of brucellosis following Strain 19 vaccination in adult cattle. This conclusion was also made by Worthington.\textsuperscript{27}

These investigations seem to confirm the conclusion of Manthei\textsuperscript{16} that administration of Strain 19 does not alter the course of the disease in cattle incubating the disease. In three herds in which different vaccinal methods were compared, the near equal numbers of infected cattle on the first herd test in the different groups suggested that they were in the incubative period when inoculations were made.

No attempts were made to correlate calfhood vaccination with possible protection after adult vaccination or subsequent serologic responses. Studies have shown that revaccination is not likely to have benefit.\textsuperscript{3,6,17,20} Since the percentage of vaccinated cattle is low in most Florida dairy herds and the ear tattoo is not assurance of proper vaccination, no consideration was given to this subject in these experimental herds.

There have been many investigations concerning routes and dosages of Strain 19 inoculations. These were summarized by Manthei.\textsuperscript{15} Cotton\textsuperscript{5} found differences produced by S/C and I/D routes of inoculation on tube test titers. Manthei et al.,\textsuperscript{14} confirmed that recedence of agglutinin titers was slower from S/C inoculations. In the Florida studies, there were less titers produced on all tests by the I/D method (Table 2). Generally, no differences in immunity have been observed.\textsuperscript{15}

The rapidity of serconversion to negative after Strain 19 inoculation is more related to age at time of inoculation and pregnancy and not as much to dose or method.\textsuperscript{2,6,15} The agglutinin response is, however, related to dosage and lower titers were found with 0.2 cc than with the standard dose.\textsuperscript{5,14} These conclusions were confirmed in herd 4 (Table 4) where large differences in serologic results were observed in a comparison of 0.25 cc and 5 cc dosages. Manthei\textsuperscript{15} concluded there were no differences in protection between the reduced and standard amounts. He stated that the minimal number of Strain 19 organisms to produce a good immunity is not known. He cautioned against using reduced doses to avoid the risk of in-
sufficient numbers of live Strain 19 due to faulty care of the vaccine. Our studies suggest that a reduced dosage administered by the S/C route was at least as effective in protection as with the larger dose. These findings are supported by recent trials in England in which no differences between 0.25 cc and 5 cc dosages in protection when administered to cattle which were later challenged. Earlier work by McDiarmid showed that a small dose (0.2 cc) gave equal protection. It is certain that agglutinins are no measurement of immunity. Parish suggests that antibody formation and cell-mediated immunity may well be opposing immunogenic processes in adult animals.

The different published studies on the abortifacient effects of Strain 19 are summarized by Manthei. There is general agreement that abortions following vaccination with Strain 19 occur but are rare. This conclusion is confirmed by observations in the herds under current investigations. The same conclusion may be made about udder infection with Strain 19. It occurs infrequently. Berman et al. did not recover vaccine organisms from 479 milk cultures conducted seven days after vaccination. Manthei concluded the establishment of Strain 19 in the udder was rare and transitory. Van Der Schaaf and Jaartsveld stated the risk was low and found only three of 502 infected quarters were shedding Strain 19. There appears to be no public health significance.

It is impossible to institute all the management changes necessary for ideal brucellosis control under Florida dairy herd conditions. Segregation of preparturient cattle, herd divisions into small units, and isolation of replacement cattle for repeated retests are impractical. Technical problems such as long incubation periods and seronegative infected cattle which abort or calve normally would remain. In large populations these become more likely occurrences and threats to brucellosis control efforts. Therefore, the most effective method for control of brucellosis is through vaccination and the most practical system is immunization of adult cattle. The means exist for vaccination of herds to produce effective, economical, and rapid immunity. These can be combined with accurate diagnostic tests to greatly reduce the incidence of brucellosis in large cattle populations.

CONCLUSIONS

An evaluation was made of the effectiveness of Strain 19 in reducing brucellosis in five large Florida dairy herds. There was more than an 80 percent reduction in numbers of cattle sold when comparisons were made in prevaccination methods and nine months or more after vaccination. Vaccinal methods included standard doses administered to all cattle at one time and at the end of lactation, and reduced doses inoculated intradermally, subcutaneously, and in the conjunctival sac. The serologic procedures included the tube, mer-
captoethanol, card and rivanol agglutination tests and the complement-fixation test. Bacteriologic studies were performed on a large number of selected cattle.

Large differences were observed among the serologic procedures performed on serums of cattle vaccinated by the various methods. The complement-fixation test became negative more rapidly after vaccination. The rivanol test was also a useful serologic procedure in differentiation of post-vaccinal titers. The tube, mercaptoethanol, and card tests were of limited value and proved to be too sensitive in Strain 19 vaccinated cattle.

Differences in immunogenicity between vaccinal methods within herds were minimal.

Post-vaccinal abortions and udder infections from Strain 19 inoculations were rare. There were definite, but transient, losses of milk production following vaccination and amounts varied according to vaccinal method.

The diagnostic titer problems caused by the administration of Strain 19 can be largely eliminated by using reduced doses of Strain 19 and supplemental test procedures.

Vaccination of adult cattle is an economical, efficient, and practical method of reducing brucellosis in large cattle populations. It will not totally eliminate the disease but infected cattle can be detected through practical and accurate diagnostic procedures.
Table 1 - Relationship of Time of Vaccination, Infection, and Serologic Results in a Large Dairy Herd Vaccinated with a Standard Dosage (5 cc) of Strain 19.

<table>
<thead>
<tr>
<th>Months Post-Vaccination</th>
<th>1-3</th>
<th>4-6</th>
<th>7-9</th>
<th>10-12</th>
<th>13-15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube</td>
<td>41 N 10 20 6 10 13 6.5 2.5 19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME</td>
<td>56 t 36 7.5 17.5 3 27 3 6 8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Card</td>
<td>70 D 55 5 47.5 1 34 2.5 40 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RIV</td>
<td>24 t 10.5 26 5 12 3 28.5 .5 100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CF</td>
<td>16 r 5.5 48 1 71 1 100 .5 100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of Cows</th>
<th>1196</th>
<th>993</th>
<th>882</th>
<th>696</th>
<th>623</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Infected</td>
<td>27</td>
<td>5</td>
<td>6 (1)</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

( ) = Strain 19 infection

Table 2 - Relationship of Time of Vaccination, Infection and Serologic Results in Adult Cattle Inoculated Subcutaneously (S/C) and Intradermally (I/D).

<table>
<thead>
<tr>
<th>Method of Inoculation</th>
<th>1-3</th>
<th>4-6</th>
<th>7-9</th>
<th>10-12</th>
<th>13-15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Method</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tube</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Positive</td>
<td>43.5</td>
<td>15.5</td>
<td>15</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>% Infected</td>
<td>Not Studied</td>
<td>30</td>
<td>73</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>ME</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Positive</td>
<td>46</td>
<td>14</td>
<td>54</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>% Infected</td>
<td>Not Studied</td>
<td>8</td>
<td>31</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Card</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Positive</td>
<td>86</td>
<td>63</td>
<td>66</td>
<td>39</td>
<td>33</td>
</tr>
<tr>
<td>% Infected</td>
<td>Not Studied</td>
<td>6.5</td>
<td>13</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>RIV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Positive</td>
<td>13</td>
<td>5.5</td>
<td>10</td>
<td>4.5</td>
<td>3</td>
</tr>
<tr>
<td>% Infected</td>
<td>Not Studied</td>
<td>44.5</td>
<td>100</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>CF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Positive</td>
<td>13</td>
<td>2</td>
<td>6.5</td>
<td>4.5</td>
<td>.5</td>
</tr>
<tr>
<td>% Infected</td>
<td>Not Studied</td>
<td>67</td>
<td>100</td>
<td>100</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of Cows</th>
<th>188</th>
<th>182</th>
<th>184</th>
<th>180</th>
<th>178</th>
<th>156</th>
<th>173</th>
<th>154</th>
<th>165</th>
<th>148</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Infected</td>
<td>Not Studied</td>
<td>8</td>
<td>9</td>
<td>1(1)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

( ) = Strain 19 Infection
Table 3 - Chronological History of a Large Dairy Herd (Approximately 8000) Tested for Brucellosis from June 1975 to September 1976.

<table>
<thead>
<tr>
<th>MONTHS</th>
<th>JUNE</th>
<th>JULY</th>
<th>AUG - OCT</th>
<th>NOV - JAN</th>
<th>FEB - APR</th>
<th>MAY - JUN</th>
<th>JUL - SEPT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle Tested</td>
<td>Dry Herd</td>
<td>Retest &amp; Drying Off</td>
<td>Dry Herd</td>
<td>Drying Off</td>
<td>Drying Off</td>
<td>N Off</td>
<td>Drying Off (Adult Vaccinates)</td>
</tr>
<tr>
<td>Number Tested</td>
<td>1568</td>
<td>1723</td>
<td>1844</td>
<td>1553</td>
<td>2007</td>
<td>1235</td>
<td></td>
</tr>
<tr>
<td>Number Reactors (Card Test)</td>
<td>265</td>
<td>148</td>
<td>242</td>
<td>273</td>
<td>447</td>
<td>128*</td>
<td></td>
</tr>
<tr>
<td>Percent Positive</td>
<td>16.9</td>
<td>8.6</td>
<td>13.1</td>
<td>17.6</td>
<td>22.3</td>
<td>10.4*</td>
<td></td>
</tr>
</tbody>
</table>

*Based upon Rivanol and Complement Fixation Test Results

Table 4 - Relationship of Time of Vaccination and Infection to Serologic Results in Adult Cattle Inoculated Subcutaneously (5 cc) and with a Reduced Dosage (.25 cc) of Strain 19.

<table>
<thead>
<tr>
<th>Months Post-Vaccination</th>
<th>1 - 3</th>
<th>4 - 6</th>
<th>7 - 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method of Inoculation</td>
<td>5 cc</td>
<td>.25 cc</td>
<td>5 cc</td>
</tr>
<tr>
<td>Test Method</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tube</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Positive</td>
<td>13</td>
<td>8</td>
<td>6.5</td>
</tr>
<tr>
<td>% Infected</td>
<td>51</td>
<td>88</td>
<td>30</td>
</tr>
<tr>
<td>ME</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Positive</td>
<td>45</td>
<td>19.5</td>
<td>16</td>
</tr>
<tr>
<td>% Infected</td>
<td>15</td>
<td>35</td>
<td>12</td>
</tr>
<tr>
<td>Card</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Positive</td>
<td>36</td>
<td>13.5</td>
<td>18</td>
</tr>
<tr>
<td>% Infected</td>
<td>18</td>
<td>51</td>
<td>11</td>
</tr>
<tr>
<td>RIV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Positive</td>
<td>14</td>
<td>8</td>
<td>5.5</td>
</tr>
<tr>
<td>% Infected</td>
<td>47</td>
<td>86</td>
<td>35</td>
</tr>
<tr>
<td>CF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Positive</td>
<td>8.5</td>
<td>7.5</td>
<td>3</td>
</tr>
<tr>
<td>% Infected</td>
<td>78</td>
<td>88</td>
<td>73</td>
</tr>
</tbody>
</table>

Number Cattle Tested: 436, 439, 407, 409, 271, 264
Number Infected: 29 (5), 30 (3), 8, 5 (1), 2, 2

( ) = Strain 19 Infection
### Table 5 - Comparison of 3 Groups of Cattle: Relationship of Test Results, Infection, and Inoculation with Strain 19 Administered by the Subcutaneous (S/C) and Conjunctival (I/C) Routes with Unvaccinated Controls.

<table>
<thead>
<tr>
<th>Months Post-Inoculation</th>
<th>2</th>
<th>4</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S/C</td>
<td>I/C</td>
<td>Controls</td>
</tr>
<tr>
<td><strong>Test Method</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tube</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Positive</td>
<td>49</td>
<td>6</td>
<td>3.5</td>
</tr>
<tr>
<td>% Infected</td>
<td>12</td>
<td>95</td>
<td>100</td>
</tr>
<tr>
<td><strong>ME</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Positive</td>
<td>92</td>
<td>14</td>
<td>5.5</td>
</tr>
<tr>
<td>% Infected</td>
<td>6</td>
<td>41.5</td>
<td>62.5</td>
</tr>
<tr>
<td><strong>Card</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Positive</td>
<td>86</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>% Infected</td>
<td>7</td>
<td>51.5</td>
<td>83</td>
</tr>
<tr>
<td><strong>Rivonal</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Positive</td>
<td>76</td>
<td>8</td>
<td>3.5</td>
</tr>
<tr>
<td>% Infected</td>
<td>7.5</td>
<td>71</td>
<td>100</td>
</tr>
<tr>
<td><strong>CF</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Positive</td>
<td>17</td>
<td>6.5</td>
<td>3.5</td>
</tr>
<tr>
<td>% Infected</td>
<td>34</td>
<td>89.5</td>
<td>100</td>
</tr>
</tbody>
</table>

| Number Tested | 314 | 290 | 143 | 252 | 255 | 132 | 235 | 236 | 114 |
| Number Infected | 18(5) | 15(2) | 5 | 9(4) | 7(3) | 9 | 6(1) | 6(2) | 5 |

( ) = Strain 19 Infection

### Table 6 - Comparison of Cattle Considered Infected in Different Groups within 4 Large Dairy Herds.

<table>
<thead>
<tr>
<th>Approximate Herd Size</th>
<th>Ave. No. Reactors Per Month</th>
<th>No. Reactors at Herd Vaccination</th>
<th>Group Identification</th>
<th>First Herd Test</th>
<th>Second Herd Test</th>
<th>Third Herd Test</th>
<th>Fourth Herd Test</th>
<th>Fifth Herd Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>900</td>
<td>10.8</td>
<td>21</td>
<td>5 cc Subcutaneous</td>
<td>22</td>
<td>5</td>
<td>5</td>
<td>6(1)</td>
<td>3</td>
</tr>
<tr>
<td>400</td>
<td>10</td>
<td>11</td>
<td>5 cc Subcutaneous</td>
<td>7</td>
<td>1</td>
<td>(1)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.2 cc Intradermal</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Calvhood Entered</td>
<td>35</td>
<td>5</td>
<td>5</td>
<td>6(1)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 cc Subcutaneous</td>
<td>27 (5)</td>
<td>8</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.25 cc Subcutaneous</td>
<td>27 (3)</td>
<td>4 (1)</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>12.7</td>
<td>110</td>
<td>5 cc Subcutaneous</td>
<td>16 (5)</td>
<td>6 (1)</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>750</td>
<td>12.1</td>
<td>16</td>
<td>.1 cc Conjunctival</td>
<td>14 (3)</td>
<td>5 (1)</td>
<td>4 (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Controls</td>
<td>5</td>
<td>9</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

( ) = New Strain 19 Infection
Table 7 - Relationship of Serologic Classification, Probable Infection and Bacteriologic Results.

<table>
<thead>
<tr>
<th>Test Method and Classification</th>
<th>Total Tested (%)</th>
<th>Number Probably Infected</th>
<th>Number Culture Attempts</th>
<th>Culture Positive Field Strains (%)</th>
<th>Strain 19 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube N</td>
<td>6202 (71)</td>
<td>2 (.03)</td>
<td>32</td>
<td>1 (3.0)</td>
<td>1 (3.0)</td>
</tr>
<tr>
<td>S</td>
<td>1728 (20)</td>
<td>14 (.8)</td>
<td>69</td>
<td>9 (13.0)</td>
<td>2 (2.9)</td>
</tr>
<tr>
<td>R</td>
<td>848 (9)</td>
<td>183 (21.5)</td>
<td>273</td>
<td>128 (46.8)</td>
<td>25 (9.1)</td>
</tr>
<tr>
<td>ME N</td>
<td>6797 (78)</td>
<td>0</td>
<td>22</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P</td>
<td>1951 (22)</td>
<td>198 (100)</td>
<td>352</td>
<td>138 (39.2)</td>
<td>28 (7.9)</td>
</tr>
<tr>
<td>Card N</td>
<td>5934 (68)</td>
<td>0</td>
<td>21</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P</td>
<td>2814 (32)</td>
<td>198 (100)</td>
<td>353</td>
<td>138 (39.2)</td>
<td>28 (7.9)</td>
</tr>
<tr>
<td>Riv N</td>
<td>8023 (92)</td>
<td>5 (.06)</td>
<td>63</td>
<td>5 (7.9)</td>
<td>2 (3.2)</td>
</tr>
<tr>
<td>P</td>
<td>725 (8)</td>
<td>193 (26.6)</td>
<td>311</td>
<td>133 (42.7)</td>
<td>26 (8.4)</td>
</tr>
<tr>
<td>CF N</td>
<td>8413 (96)</td>
<td>5 (.06)</td>
<td>102</td>
<td>4 (3.9)</td>
<td>4 (3.9)</td>
</tr>
<tr>
<td>P</td>
<td>335 (4)</td>
<td>193 (57.6)</td>
<td>272</td>
<td>134 (49.3)</td>
<td>24 (8.8)</td>
</tr>
<tr>
<td>Totals</td>
<td>8748</td>
<td>198 (2.3)</td>
<td>374</td>
<td>138 (36.9)</td>
<td>28 (7.5)*</td>
</tr>
</tbody>
</table>

*5 Isolations from Previous Culture Positive Cows
REFERENCES


EVALUATION OF SERA OF LEPTOSPIRAL VACCINATED CATTLE FOR BRUCELLA ANTIBODIES

L. E. Hanson, DVM, D. N. Tripathy, DVM, and M. E. Mansfield, DVM

INTRODUCTION

The function of diagnostic serologic tests is to provide definitive identification of antibodies to specific disease agents or antigens. Many leptospiral and brucella agglutination tests have been conducted on sera of cattle following natural infection with no evidence of cross reactions. However, questions have been raised concerning effects of leptospiral multivalent bacterin administration on subsequent brucella reactions. Scheidy and Live in 1957 reported no cross reactions were produced in 5 L. pomona vaccinated cattle which had previously received Brucella abortus strain 19 vaccine. Since that time, a number of multivalent leptospiral bacterins have been developed and have been used extensively in cattle in the United States. This report provides serologic information on sera of cattle which received multivalent leptospiral bacterins containing 2 to 6 serotypes and have been revaccinated from one to 4 times.

MATERIAL AND METHODS

Leptospiral bacterins: The cattle in this study received various commercial and experimental leptospiral bacterins. The L. pomona bacterin used in the Dixon Springs Agricultural Center (DSAC) cattle in 1965 and 1966 was produced by the Fort Dodge Laboratories, Fort Dodge, Iowa in Stuart’s medium which contained rabbit serum. The bivalent pomona and hardjo bacterin, the trivalent grippotyphosa, hardjo and pomona bacterin, and the experimental pentavalent bacterin containing canicola, grippotyphosa, hardjo,icterohaemorrhagiae, and pomona bacterins produced by Affiliated Laboratories, White Hall, Illinois were whole cell bacterins prepared in bovine albumin polysorbate 80 medium. A pentavalent cell wall bacterin containing canicola, grippotyphosa, hardjo,icterohaemorrhagiae and pomona antigen was provided by Dr. R. Johnson at the University of Minnesota. An experimental trivalent (grippotyphosa, hardjo, pomona) and a monovalent szwajizak whole cell bacterin produced at the University of Illinois in bovine albumin polysorbate 80 medium was used in some studies (Tripathy et al., 1976a; Tripathy et al., 1976b; and Tripathy et al., 1976c).

From the College of Veterinary Medicine and the Illinois Agricultural Experiment Station.
Supported by the Illinois Agricultural Experiment Station Hatch Project 70-302. The authors acknowledge the technical assistance of Mrs. R. Marlowe and Mr. W. Manuel, and the Illinois Department of Agriculture Serology Laboratory.
Microscopic agglutination (MA) tests for leptospiral antibodies were conducted with appropriate serotype antigens according to the procedure described in the U. S. Livestock Sanitary Proceedings of 1960. The test was reported positive if 50% or more of the leptospires were agglutinated as determined by darkfield microscopy in serum dilutions of 1:100 or greater. In the experimental leptospiral vaccine studies, incomplete reactions at 1:100 were also included to provide information on all leptospiral serum reactions.

Brucella tests used were the standard rapid plate serum agglutination test and the serum card test (Malcolm, 1932; Nicoletti, 1967). The tests were conducted at the College of Veterinary Medicine from 1960-1970 and at the Illinois Department of Agriculture Serology Laboratory in Springfield, Illinois from 1971-1975.

*Leptospira hardjo* challenge was conducted in one study previously reported by Tripathy *et al.*, 1976a. The sera of the cattle were collected just prior to challenge and 4 weeks later.

**Cattle:** All the cattle in the OSAC studies were Herefords from the DSAC herd (Hanson *et al.*, 1972). The DSAC cattle sera were collected annually in the fall from the entire herd. The cattle range in age from 6 months to 14 years. The calves in the DSAC herd received *Brucella abortus* strain 19 vaccine until 1968. All the cattle tested in 1966 and 1967 had received *L. pomona* bacterin from Fort Dodge Laboratories one year previously. From 1968 to 1973 all the DSAC cattle had received a *hardjo* and *pomona* bacterin one year previously and in 1974 and 1975 the cattle had previously received a trivalent (*grippotyphosa, hardjo, pomona*) bacterin. Some bulls were added to the herd in 1970 which had not received leptospiral bacterins.

The experimental multivalent bacterin studies involved Hereford and Angus cattle purchased at approximately 8-12 months of age. None of these cattle received brucella vaccine.

A privately owned herd of Hereford cattle was included in this study as the cattle had been vaccinated with multivalent bacterin since 1968. The cattle had received a *pomona* and *harjo* bacterin from 1968 through 1973 and a *pomona, hardjo* and *grippotyphosa* bacterin in 1974. The sera were tested in 1975 with leptospiral and brucella antigens.

**RESULTS**

The results of the annual test from 1966 through 1975 on the sera of the DSAC cattle are compiled in Table 1. During this period, a total of 8500 sera were tested with only 5 suspicious reactions for brucellosis. One of the positive sera in 1966 and one in 1970 were from cattle which had been vaccinated as calves with *Brucella abortus* strain 19 vaccine. In 1970, one serum came from a bull added to the herd which had not been vaccinated with leptospira bacterin. None of the 5 brucella suspect sera reacted with any of 5 leptospiral antigens on the MA test although all the cattle received leptospiral bac-
terins. The cattle tested in 1966 had previously received a commercial *pomona* bacterin one or more times. The cattle tested from 1968 to 1973 had received a *pomona* and *hardjo* bacterin and the cattle after 1973 received a commercial *grippotyphosa, hardjo, pomona* bacterin. The MA test reactors to *grippotyphosa* and *hardjo* were due to persisting antibodies produced in previous infections (Table 1). In 1975, some sera tested were from 222 cattle which had received 4 or more annual vaccinations and 45 cattle tested had been vaccinated annually for at least 10 years none of which had cross reactions with *Brucella abortus* antigens.

The tests conducted with various experimental bacterins are shown in Tables 2, 3 and 4. None of the cattle sera tested developed cross reactions to Brucella antigen in serum plate or card test even though various leptosiral bacterins involving 3 to 6 serotypes were administered to the cattle. Also in the studies reported in Table 2, which involved sera of cattle before and following challenge with a *hardjo* culture, the sera did not have cross reactions to brucella test antigens.

The private Hereford herd tested in 1975 had 155 cattle. The cattle received multivalent vaccine from 1968 through 1974. No positive brucella reactors were detected in the sera tested. Six *hardjo* and one *pomona* reaction was detected.

**SUMMARY**

The serologic tests conducted on more than 8500 sera of cattle following various natural leptosiral infections or after vaccination with single or multivalent leptosiral bacterins administered did not demonstrate any evidence of cross reactions to brucella antigens with the serum plate or serum card tests. These studies involved leptosiral bacterins prepared in 2 types of media, Stuart’s and bovine albumin polysorbate 80 media, which were administered from one to 5 times in one year.
TABLE 1

SEROLOGIC REACTIONS OF DSAC CATTLE SERA TO LEPTOSPIRA AND BRUCELLA ANTIGENS IN DSAC HERD DURING A 10-YEAR PERIOD

<table>
<thead>
<tr>
<th>Year</th>
<th>No. sera</th>
<th>Vaccination</th>
<th>Pomona No.</th>
<th>Pomona %</th>
<th>Grippotyphosa No.</th>
<th>Grippotyphosa %</th>
<th>Hardjo No.</th>
<th>Hardjo %</th>
<th>Brucella No.</th>
<th>Brucella %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966</td>
<td>810</td>
<td>P</td>
<td>43</td>
<td>5.3</td>
<td>7</td>
<td>0.8</td>
<td>428</td>
<td>52.0</td>
<td>2*</td>
<td>0.2</td>
</tr>
<tr>
<td>1967</td>
<td>754</td>
<td>P</td>
<td>4</td>
<td>0.5</td>
<td>3</td>
<td>0.4</td>
<td>260</td>
<td>34.4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1968</td>
<td>756</td>
<td>P, H</td>
<td>22</td>
<td>2.9</td>
<td>10</td>
<td>1.3</td>
<td>254</td>
<td>33.6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1969</td>
<td>876</td>
<td>P, H</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0.2</td>
<td>204</td>
<td>23.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1970</td>
<td>813</td>
<td>P, H</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0.3</td>
<td>82</td>
<td>10.1</td>
<td>3**</td>
<td>0.4</td>
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<tr>
<td>1971</td>
<td>769</td>
<td>P, H</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0.3</td>
<td>49</td>
<td>6.4</td>
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<td>1972</td>
<td>860</td>
<td>P, H</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>1.6</td>
<td>77</td>
<td>8.9</td>
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<tr>
<td>1973</td>
<td>905</td>
<td>P, H</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0.3</td>
<td>84</td>
<td>9.3</td>
<td>0</td>
<td>0</td>
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<tr>
<td>1974</td>
<td>1054</td>
<td>P, H, G</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0.3</td>
<td>45</td>
<td>4.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1975</td>
<td>903</td>
<td>P, H, G</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0.5</td>
<td>18</td>
<td>1.9</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Suspects - calfhood vaccinated and leptospira negative

**Suspects - leptospira negative

P = pomona; H = hardjo; G = grippotyphosa

1966-1969 = Brucella plate agglutination test

1970-1975 = Brucella plate agglutination and card test
TABLE 2
REACTIONS OF BOVINE SERA FROM CATTLE RECEIVING VARIOUS LEPTOSPIRAL SEROTYPE BACTERINS TO BRUCELLA AND LEPTOSPIRAL ANTIGENS

<table>
<thead>
<tr>
<th>Bacterin</th>
<th>AGGLUTINATION REACTIONS TO CATTLE SERA</th>
<th>Preleptospiral challenge</th>
<th>4 weeks after L. hardjo challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No. cattle</td>
<td>C</td>
</tr>
<tr>
<td>Whole cell (H, P)</td>
<td></td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Whole cell (G, H, P)</td>
<td></td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Cell wall (C, G, I, H, P)</td>
<td></td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Controls (No bacterin)</td>
<td></td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

C = canicola, G = grippotyphosa, I = icterohaemorrhagiae; H = hardjo; P = pomona

*MA = microscopic agglutination test (complete or incomplete at 1:100)

**Brucella tests - plate and card

Information compiled partially from data reported by Tripathy et al., 1976, Vet. Res., 37:51

TABLE 3
SEROLOGIC REACTIONS AGAINST LEPTOSPIRA AND BRUCELLA ANTIGENS WITH SERA OF CATTLE RECEIVING SINGLE AND REPEATED LEPTOSPIRA BACTERIN INOCULATES

<table>
<thead>
<tr>
<th>Trivalent bacterin*</th>
<th>No. animals</th>
<th>No. positive reactions**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>P</td>
</tr>
<tr>
<td>1 dose</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>5 doses at 2 month intervals</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>None (control)</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

*Bacterin containing grippotyphosa, hardjo and pomona - Affiliated Laboratories

**Tests conducted 10 months following first vaccination

***Plate and card agglutination tests

Leptospira titers represent incomplete (I) 1:100 or complete 1:100
<table>
<thead>
<tr>
<th>Bacterin</th>
<th>No. Animals</th>
<th>No. Positive Reactions</th>
<th>MA - Leptospira</th>
<th>Brucella</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole cell (CGIHP)*</td>
<td>10</td>
<td>0 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole cell (CGIHP) + (S)**</td>
<td>10</td>
<td>0 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controls (no bacterin)</td>
<td>9</td>
<td>0 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*C = canicola; G = grippotyphosa; I = icterohaemorrhagiae; H = hardjo; P = pomona - commercial bacterin - Affiliated Laboratories

**S = szwajizak - experimental bacterin

MA - microscopic agglutination tests of 1:100 or greater

Brucella - plate and card test for Brucella abortus
VACCINATED CATTLE FOR BRUCELLA ANTIBODIES

REFERENCES


PROGRESS OF THE COOPERATIVE STATE-FEDERAL
BRUCELLOSIS ERADICATION PROGRAM

Billy G. Johnson,* DVM

The year just completed was one during which the State-Federal Brucellosis Eradication Program has been reviewed, challenged, criticized, and at the same time, supported by many others. It has been a year when some States have made tremendous progress, others have recognized problem areas and initiated steps to solve those problems, and certain States have recognized problems and are still searching for solutions. A Brucellosis Technical Commission has been appointed to study the effectiveness and feasibility of the Brucellosis Eradication Program and to submit recommendations regarding changes needed in the program. The National Academy of Sciences is reviewing research being conducted and research needs in the program.

The three previous reports to this group have shown a rate of spread of brucellosis that was exceeding the program efforts to detect and contain the disease. Funding increases in 1975 and 1976 were used to increase program activities and efforts to contain the disease. The effects of these efforts, in reversing the upward trend, can now be measured on a national level by reviewing the program data for the previous year.

BLOOD TESTING CATTLE
(Figure 1)

The upward trend in cattle blood tested continued in FY 1976 when 22 million animals were sampled. This significant increase is largely due to a steep rise in the number of animals being sampled under the Market Cattle Identification Program (MCI). There were 14.6 million animals tested under the MCI program in FY 1976 and 7.4 million cattle tested on farms or ranches (additional 900,000). Although the number of total animals tested was up by 24.3 percent, the number of reactors rose by only 13.2 percent to 283,000. The reactor rate was 1.29 reactors per 100 blood tests compared with 1.46 in 1975, (1.34 in 1974 and 1.16 in 1973). This marks the first reduction in the reactor rate since it began to increase in 1973.

MARKET CATTLE IDENTIFICATION SYSTEM
(Figure 2)

The 14.6 million animals tested under the MCI surveillance program in FY 1976 was an increase of 3.4 million samples over FY 1975. This increase includes an additional 2.2 million animals tested at packing plants and a 1.2 million increase at livestock markets. This

*Hyattsville, MD
30.4 percent increase in animals sampled was accompanied by a 20 percent increase in reactors with an overall MCI reactor rate of 0.658. This reactor rate, which possibly may be the best overall indication of program progress, is down from 0.71 in 1975 and 0.70 in 1974. This also is the first decrease since 1973.

MCI reactors were traced to 25,170 herds of origin. Infection was disclosed in 8,912 herds (35.4 percent) with an animal infection rate of 16.4 percent, 1.4 percent higher than the previous year.

MILL RING TEST
(Figure 3)

There were 2,323 herds reacting to the BRT in FY 1976 representing 0.30 percent of herds sampled. Tests were conducted on 2,174 herds with infection being disclosed in 594 herds (27 percent). In those herds where brucellosis was detected, 3.8 percent of the animals tested were reactors on the initial test, compared to 3.4 percent the previous year.

There were 786,172 ring test samples collected in FY 1976, compared to 855,401 in FY 1975. This downward trend has continued since FY 1965 when over 1.8 million tests were run. This reduction has resulted from the decrease in numbers of dairies with a corresponding increase in herd size. This points out the critical need to:

1. Collect BRT samples from all dairies no less than three times per year.
2. Adjust sensitivity of BRT according to herd size.

BRUCELLOSIS INFECTED HERDS
(Figures 4 & 5)

A total of 16,910 infected herds was disclosed in the 50 States in FY 1976. This represented a 3.1 percent increase over the previous year. This small increase, compared with the 30.4 percent increase in sampling rate under the MCI program, is another indication that the rapidly increasing infection rate started in 1972 is being slowed. Five-hundred and forty-eight of the total infected herds were found in 28 Certified-Free States, compared with 648 in the previous year. These were primarily the Northern and Northeastern States. The States with increases in the number of infected herds were primarily in the western part of the country.

Ninety-point-four percent of the total infected herds were distributed among 11 States. Texas accounted for 34.9 percent of the total. Louisiana, Mississippi, and Tennessee accounted for 27.4 percent of the total. Seven States, including Alabama, Arkansas, Florida, Georgia, Kentucky, Missouri, and Oklahoma collectively totaled 28.1
percent with each State experiencing between 300 and 1,000 infected herds. Fourteen States had between 30 and 300 infected herds and 25 States had less than 30 infected herds.

CERTIFICATION STATUS JUNE 30, 1976
(Figure 6)

A total of 1,976 counties, representing 62 percent of all counties, were Certified-Free on June 30, 1976. This is a reduction of 14 counties during the year. The number of Certified-Free States is down one from the year before. One-thousand-one-hundred and seventy-two counties in 22 States and Puerto Rico held Modified-Certified status at the end of FY 1976. Only 3 counties were listed as non-certified at the end of the fiscal year, although actions were taken to remove the certification status from 130 additional counties during the year. Deficiencies were corrected in these counties and certification status was restored.

Calfhood Vaccination
(Figure 7)

There were 3.8 million calves vaccinated during FY 1976, compared to 3.7 million in FY 1975. Over 49 percent of the calves were again vaccinated in the Certified-Free States. This is approximately 31 percent of the eligible calves in those areas. Fifteen and three-tenths of the eligible calves were vaccinated in the Modified-Certified States.

Swine Brucellosis

The Swine Brucellosis Program showed little expansion in FY 1976 and most eradication activity was centered in those States which had active ongoing programs when the year began.

The number of swine blood tested declined from 2.4 million in FY 1975 to 1.6 million in FY 1976 (Figure 8). This total includes 336,000 sows and boars tested at livestock markets and 1.2 million tested at slaughter under the Market Swine Testing Program (MST).

Most of the decrease in total swine testing can be attributed to 32 percent fewer sows and boars being slaughtered in FY 1976 than in the preceding year, and this resulted in a similar decrease in the number of MST samples collected.

The MST reactor rate was 0.027 percent compared to 0.04 percent in FY 1975. This low rate was influenced by the predominance of samples (82 percent) that originated in the Validated Brucellosis-Free States or in Iowa where the program has been underway for several years, and the prevalence of the disease reduced.
In contrast, heavy infection found on area testing in two New England States (Massachusetts and New Hampshire) caused the national infection rate on farm tests to increase from 0.24 to 0.42 percent and the rate on all tests to increase from 0.07 to 0.11 percent over the preceding fiscal year (Figure 9).

One State, South Dakota, attained validated status during the year — joining Arkansas, Colorado, Maine, Minnesota, Montana, Nevada, Oregon, Utah, Vermont, Washington, Wisconsin, and Wyoming on the list of Validated Brucellosis-Free States. Arizona failed to meet testing standards for revalidation and its status as a validated State was terminated.

The number of Validated Brucellosis-Free Counties increased from 694 to 736 during FY 1976 (Figure 10). In addition to all counties in the validated States, there were free counties in California-57; Hawaii—3; Massachusetts—8; Michigan—13; and Puerto Rico—61.

There was a decrease in Validated Brucellosis-Free herds from 3,905 at the beginning of FY 1976 to 3,798 at its conclusion. This program statistic has been subject to considerable up and down variation since the qualifying standards for herd validation was reduced from two clean tests to one. (Figure 11).

This makes it possible for the validated herd totals to increase rapidly when herds are automatically qualified for status during routine testing for county or State validation, then drop just as rapidly when owners permit this status lapse at the end of a 1-year validation period.

Dr. Gerald Fichtner, in presenting the status report a year ago, identified a number of weaknesses in the program. He also stated, "Within the past year, the livestock industry has worked with regulatory agencies to build momentum toward facing up to our program deficiencies and initiating corrective action. Such momentum must be sustained in the future so that the guilt of complacency, which this program experienced several years ago, will not be repeated. Only when this momentum is built to the point where the rate of disease detection and elimination greatly exceeds the rate of spread will we see the eradication horizon."

We have seen from the data presented that the MCI reactor rate has declined from .71 in 1975, to .658 in 1976, the reactor rate of all animals tested was reduced from 1.46 per hundred to 1.29, and the number of infected dairy herds found through the BRT surveillance program dropped from 646 to 594. We also saw a reduction in the number of infected herds in half of our Certified-Free States. These indicators do not show that the rate of detection and elimination greatly exceeds the rate of spread but there are indications that
improvements have been made so that our efforts to eliminate the
disease are approaching the rate of spread in many areas of the
country and may be exceeding the rate of spread in some areas.

At the same time, there are deficiencies that must receive our
attention if the momentum is built to the point where eradication
is possible.

1. The infection remains high in the South Central and South-
eastern States. Two of these States have started intensified programs
that will lead to rapid eradication. Other States are ready to imple-
ment similar procedures. Resources are needed to implement these
or other increased efforts needed in these States.

2. The Certified-Free States in the West are still experiencing
increased incidence of disease. The problems involved must be identi-
fied and proper program standards implemented to correct this situ-
ation.

3. The low incidence States in the North Central and Northeast
areas have made progress in reducing the number of infected herds.
The challenge here must be to prevent reintroduction of the disease
and to reach zero infection.

A large number of diseases have been eradicated from the U.S.
livestock population. Few were done without problems occurring but
these problems were overcome because the industry and veterinary
professions were dedicated to the point of searching out the solutions
needed. This same dedication is now needed as we get the Brucellosis
Eradication Program headed back on the road toward total eradica-
tion.
Brucellosis Eradication

**BLOOD TESTING: CATTLE**

MILLIONS CATTLE TESTED

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<td>Farm or Ranch</td>
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<td>13.6</td>
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<td>17.7</td>
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<td>MCT</td>
<td>10.3</td>
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<td>16.0</td>
<td>19.0</td>
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THOUS. REACTORS FOUND

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<th></th>
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<tr>
<td>Farm or Ranch</td>
<td>149</td>
<td>119</td>
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<td>158</td>
<td>196</td>
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<td>150</td>
<td>190</td>
<td>240</td>
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**MARKET CATTLE TESTING PROGRAM**

FISCAL YEAR | AT PACKING PLANTS | OTHER | MILLION COWS BLOOD TESTED |
-------------|-------------------|-------|--------------------------|
1968         | 59.0%             | 41.0% | 14.6 Mil.                |
1970         | 58.2%             | 41.8% |                         |
1972         | 62.2%             | 37.8% |                         |
1973         | 63.3%             | 36.7% |                         |
1974         | 60.6%             | 39.4% |                         |
1975         | 70.0%             | 30.0% |                         |
1976         | 69.6%             | 30.4% |                         |
1977         |                   |       |                         |

**Fig. 1**

US Department of Agriculture Veterinary Services Animal and Plant Health Inspection Service

**Fig. 2**
**Brucellosis Eradication**

**MILK RING TEST RESULTS (BRT)**

Fig. 3

- Total Suspicious BRT Tests
- Follow-up Herd Blood Tests
- Infected Herds Found

<table>
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<tr>
<th></th>
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<tbody>
<tr>
<td>Suspicious</td>
<td>10,126</td>
<td>8,080</td>
<td>4,785</td>
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<td>2,170</td>
<td>2,577</td>
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**Fig. 4 **BRUCELLOSIS INFECTED HERDS FOUND

In Noncertified, Modified Certified, and Certified-Free States

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States Where Infected Herds Found

- Certified-Free
- Modified Certified
- Noncertified

**Fiscal Year**

- 1968
- 1969
- 1970
- 1971
- 1972
- 1973
- 1974
- 1975
- 1976

**Number of States**

- Non-Certified
- Modified Certified
- Certified-Free
Fig. 5

Fig. 6
Fig. 11
REPORT OF THE COMMITTEE ON BRUCELLOSIS

Chairman: L. E. Bartelt, Sacramento, CA  
Co-Chairman: B. W. Hawkins, Ontario, OR


All Committee members were in attendance except five. Open sessions were held from 1-5 PM on Monday and 1:30 to 3:15 PM Tuesday and then the committee went into executive session from 3:15 to 11:30 PM Tuesday. Additional executive committee deliberations were continued Wednesday from 9 to 11:30 AM conclusion.

Proposals, recommendations and statements were presented in open session by the following:

Florida Association of Livestock Markets  
Florida Cattlemen's Association  
National Milk Producers' Association  
American National Cattlemen's Association  
Colorado Department of Agriculture  
Montana Department of Livestock  
Livestock Laws Report Commission  
Dairy Farmers Inc. of Florida  
Dr. Frank Mulhern, Administrator, APHIS  
Dr. David Berman, National Brucellosis Technical Commission  
Dr. Paul Becton, Director, USDA Brucellosis Programs  
Texas Animal Health Commission  
Dr. A. E. Lewis, Director, Contagious Disease Branch, Health of Animals, Canada  
Mr. Danforth Browne, representing Florida Dairy Interests  
Dr. L. Vanderwagen, California Dept. of Food & Agric.  
Dr. Paul Nicoletti, Epidemiologist, USDA  
Dr. John Hooper, Texas Animal Industry  
Florida Farm Bureau  
Dr. Phil Ross, National Academy of Science  
Southern Animal Health Association  
Florida Department of Agriculture & Consumer Serv.
The National Brucellosis Technical Commission was in attendance at all sessions of the Brucellosis Committee at the invitation of the Committee for the purposes of observation and obtaining information for use in their deliberations.

In the executive session business was conducted as follows:

1. American National Cattlemen's Association proposal on "special regulated feedlots" was presented to the Committee and failed to pass.

2. Presentation was made by Mr. Neal Black and unanimously approved by the Committee as follows:
   "In recognition of the fact that swine are no longer the major source of human brucellosis infection, the Committee commends progress toward eradication of brucellosis from the swine population and urges expansion of the market swine testing program and elimination of the disease from any infected herds disclosed." "Also, the Committee reiterates its appeal for inauguration of a National Identification Program for sows, boars, and stags going to slaughter."

3. The Colorado proposal was presented by Dr. Bill Tobin and a request was made to APHIS to solicit legal council in an effort to afford greater latitude in the administration of the Cooperative State and Federal Brucellosis Program that would allow for professional judgment. Recommendation was passed.

4. Request was made by Jim Cavanaugh that each member of the Brucellosis Committee be provided monthly a list of States showing the number of quarantined herds per thousand herds in the order of lowest to highest.

5. A Motion was made to reinstate the word "recommended" before Uniform Methods and Rules in the title of said document that had been deleted last year by this association. Motion passed.

6. It was moved by Mr. John Armstrong that the President of this association be asked to appoint a brucellosis scientific committee to evaluate scientific and technical information for the guidance of this committee. This committee may or may not be made up by members of the USAHA Brucellosis Committee, however, they should be members of the USAHA or the AAVLD. Motion passed.

7. It was suggested that a meeting of this committee could be called by the Chairman, after conciliation with the President, that
would deal with major issues if they arise. This meeting would be in the central USA about midyear.

8. It was further recommended that the Chairman consider this committee meeting on Sunday afternoon or evening prior to the first working day of the annual convention. Motion passed.

9. It was moved by John Armstrong that an alternate position for the S brand be established high on the tailhead and be visible from the ground level. Motion passed.

10. The following protocol for eradication of brucellosis from infected herds through use of adult vaccination with Brucella abortus strain 19 vaccine was approved:

Herds to be adult vaccinated shall be selected jointly by the State Veterinarian and the Federal Veterinarian responsible for the brucellosis program in the state where the herd is located. Factors to be considered in choosing a herd for adult vaccination shall include the following:

1. Incidence of infection in the herd.

2. Problems of eliminating infection from the herd using test and slaughter procedures prescribed by the UMR.

3. Herd abortion rate.

Vaccination, testing and supervision of herds selected shall be the responsibility of a veterinarian delegated by the State Veterinarian and Federal Veterinarian in Charge of the state's brucellosis program.

Procedures:

1. Test all eligible cattle in the herd using UMR approved test(s). Remove reactors for slaughter.

2. Vaccinate negative females with Strain 19 within 10 days of test. Identify all adult vaccinates by placing an “AV” (each letter at least 2 x 2 inches) hot brand on the right jaw and an officially coded ear tag in the right ear.

3. Add only cattle from non-quarantined herds which have passed a negative brucellosis test (UMR approved) within the preceding 10 days. Vaccinate females with Strain 19 vaccine before being placed with the herd. Add only officially vaccinated calves to the herd when the supply becomes adequate, such adequacy to be determined jointly by the State Veterinarian and VIC. Quarantined, adult-vaccinated herds may be com-
bined if jointly approved by the State Veterinarian and 

VIC.

4. Vaccinate at UMR approved age all heifer calves raised 
on the farm.

5. Maintain herd in quarantine under UMR approved 
restrictions. "AV" branded cattle shall move only on 
permit to slaughter or quarantined feedlot, just as 
"S" branded cattle, except as provided under 3 above.

6. Test all eligible cattle in herd at intervals not to exceed 
six (6) months (time may be extended or shortened 
by joint approval of State Veterinarian and VIC) 
using UMR approved test(s) and remove reactors. 
Testing should be continued until herd is eligible for 
release under the UMR.

7. While the herd is under quarantine, calves under six 
(6) months of age may move in accordance with the 
UMR. Dams found reacting to the UMR approved test 
shall be moved to slaughter with indemnity.

8. Subject to future consideration by the USAHA Bru- 
cellosis Committee, and availability of official calf 
vaccinates as replacements, an adult-vaccinated herd 
shall at the end of 24 months following the first vac- 
cination of adults be subject to all UMR requirements 
which apply to a non-adult vaccinated herd, and no 
future adult vaccination shall be permitted. However, 
previously adult-vaccinated animals will remain under 
restricted movement and special test requirements until 
sold to slaughter.

11. The Committee, after reconsideration in a special meeting, 
decided to recommend only one change in the Uniform Methods 
and Rules in Part II, Standard Procedures under K Movement 
of Quarantined and Exposed Cattle.

The change was to move the calf age from six months to eight 
months in the two places where age is indicated.

12. The Committee moved and passed that exposed cattle may move 
from a livestock market in a sealed truck to slaughter under the 
same conditions that are now allowed from a herd of origin 
without restriction.

13. The Committee approved the following for USDA and State reg- 
ulatory official guidance:
In recognition of the difficulties created in eradication of brucellosis as a result of widespread unofficial screening tests of possibly exposed animals, it was resolved that stricter controls be enacted to ban the sale of Brucella test antigens except to regulatory agencies for distribution to accredited veterinarians and regulatory personnel only, and that stricter controls for accountability be enacted and maintained to prevent the availability of test materials to all other parties at the point of use.

It is further recommended that more rigid methods of penalization of accredited veterinarians who willfully misuse their positions of trust in performance of their responsibilities as an accredited veterinarian be developed which would more effectively deter violations than is presently provided for.

14. The Committee recognizes that calf vaccination is very necessary at this time to reach the goal of eradication and urges an all out and continuing effort to achieve a very high level calf vaccination. The Committee urges the USAHA to request that the Congress provide a supplemental appropriation to support that effort. Additional indemnity funds should also be requested for herd depopulation where epidemiological studies and economics of eradication indicates a need.

15. The Committee recommends that ARS and APHIS make a determined effort to secure additional funds for research on brucellosis.

16. The Committee is concerned with the lack of progress made in securing the necessary legislation to require livestock dealers to maintain adequate records on the origin and health of cattle within their control and urges prompt action to implement such legislation on a nationwide basis.

17. The Committee sent two resolutions to the Resolutions Committee for consideration.

18. All other proposals and many variations of proposals were considered but no action was recommended at this time.

The Chairman wishes to commend the diligent effort and long hours the Committee members expended and for the interest expressed in the Committee's work.
EXPERIMENTAL MYCOTOXICOSES IN CALVES WITH AFLATOXIN, OCHRATOXIN, RUBRATOXIN, AND T-2 TOXIN

A. C. Pier, DVM, PhD; S. J. Cysewski, DVM, PhD; J. L. Richard, PhD; A. L. Baetz, PhD; L. Mitchell, DVM

A number of mycotoxins have been isolated from animal feeds and their biological effects studied in laboratory animals. Several studies have determined the effects of purified toxins at high levels which caused acute responses in livestock and poultry. However, with the exception of aflatoxin relatively few studies have been made of the effects of purified mycotoxins given to domestic animals at levels and durations that produce subacute or chronic responses. It is the latter information that must be compiled before many field conditions can be diagnosed and the economic losses caused by them ascertained. Acute intoxications are more often diagnosed because of the dramatic nature of their signs; however, in most cases the level of mycotoxins in animal feeds is below that needed to cause an acute clinical response. Economically, significant effects follow continued low level intake of known mycotoxins; these effects include reduced growth rate, lowered resistance to infection, suppression of immune responses and carcinogenicity.

Colonies of animals in commerce such as feeder cattle, dairies, market swine and poultry are particularly prone to exposure to mycotoxins because of their dependence upon stored concentrate rations. These rations may be assembled from several stored ingredients each with its own mycotoxin, thus creating situations where additive or synergistic effects must be considered.

It was the purpose of the study reported here to ascertain certain clinical, clinicopathologic, and pathological effects in calves resulting from prolonged administration of measured quantities of purified aflatoxin, ochratoxin, rubratoxin, T-2 toxin, and combinations of aflatoxin with rubratoxin.

MATERIALS AND METHODS

Twenty Jersey calves were purchased shortly after birth and delivered to the National Animal Disease Center (NADC) where they were raised to approximately 30 days of age during which time they were gradually brought from a commercial antibiotic-free milk replacer diet to a solid ration consisting of 50% calf pellets (NADC ration 548) and 50% complete cattle pellets (NADC ration 550). The calves were treated with mycotoxins as shown in Table 1.

From the National Animal Disease Center, North Central Region, Agricultural Research Service, US Department of Agriculture, P. O. Box 70, Ames, IA 50010.

The authors acknowledge the assistance of R. E. Fichtner and C. D. Anderson.

No endorsements are implied herein.
Partially purified preparations of aflatoxin, ochratoxin, and rubratoxin were prepared, dispensed into gelatin capsules and administered as previously described. Production and purification methods for T-2 toxin were similar to those reported by Burmeister, except that white cornmeal was substituted for corn grits as a substrate and the chloroform-acetone mixture was not processed in a Waring blender during the extraction procedures. The resulting T-2 toxin was dissolved in acetone and dispensed into capsules as above. Doses of all mycotoxins were administered daily for 30 days according to the weight of the calf at the start of the treatment period; they were not adjusted for subsequent weight changes. The aflatoxin dose was calculated as aflatoxin B_1 activity; ochratoxin dose was calculated according to ochratoxin A content and rubratoxin according to rubratoxin B content. T-2 toxin was calculated as total toxin extract (96% pure T-2 toxin by analysis).

The calves were observed clinically and temperature daily beginning 2 weeks before treatment. Determinations of body weight, hematocrit (PCV), leukocyte count (WBC), bromsulphalein clearance half-time (BSP T₁/₂), prothrombin time (Quick), total and differential serum protein analysis, and urinalysis (Sp. Gr, pH, glucose, ketones, protein) were conducted weekly by previously described methods. Selected serum enzyme activities and other serum chemical levels were determined by established automated methods including glutamic oxalacetic transaminase (GOT), creatinine phosphokinase (CPK), cholesterol, bilirubin and blood urea nitrogen (BUN). At the termination of the treatment period, surviving calves were killed by intravenous injection of succinyl choline and a post-mortem examination was conducted immediately. Specimens of liver, kidney, lung, heart, adrenal, pancreas, spleen, and grossly abnormal tissues were obtained and processed for histopathologic examination.

RESULTS

Minimal doses effecting discernible clinical signs were determined as follows: aflatoxin at 0.2 mg/kg/day for 14 days; ochratoxin at 1.0 mg/kg/day for 14 days; rubratoxin at 12.0 mg/kg/day for 5 days and T-2 toxin at 0.32 mg/kg/day for 9 days (Tables 2-5). While notations were made of some clinical abnormalities at lower doses, these were considered the first signs of toxin-associated dysfunction liable to be noticed. Most of the clinical changes were subjective in nature; however, changes in rate of gain in body weight provided objective data in some instances (Fig 1). (Only data differing appreciably from that obtained from the control calves is depicted in Figures 1-4; values falling within the range of those obtained from control calves were considered to be normal and were not separately plotted.)

Meaningful clinicopathologic changes were seen most frequently with BSP clearance (Fig 2), prothrombin times (Fig 3) and serum
GOT levels (Fig 4). Blood urea nitrogen (BUN) levels ranged between 7.2 to 25.5 mg/100 ml and no trends toward abnormal elevations were observed following any of the mycotoxins. Creatinine phosphokinase (CPK) values in control calves ranged between 0.07 and 0.28 IU; elevated levels were seen only in the terminal stages of acute aflatoxicosis (13th day at 0.5 mg/kg/day aflatoxin) when the CPK activity level reached 52.2 IU. Similarly both total and direct bilirubin values were elevated only in the terminal stages of acute aflatoxicosis reaching 78.0 mg/100 ml (controls 0.02-0.5) and 47.3 mg/100 ml (controls 0.0-0.52) respectively; elevations in total bilirubin were observed 4 days before death and preceded detectable changes in direct bilirubin. Serum cholesterol levels of control calves ranged between 46 to 79 mg/100 ml and were elevated (109 to 187 mg/100 ml) during aflatoxin (0.2 and 0.5 mg/kg/day) and aflatoxin/rubratoxin consumption (0.2/16.0 and 0.2/12.0 mg/kg/day).

Detailed changes observed with individual mycotoxin treatments were as follows:

Aflatoxin—The response of calves to 3 dose levels of aflatoxin are summarized in Table 2. At 0.1 mg/kg/day no clinical abnormalities were observed; weight gains were equivalent to those of control calves and only minimal changes in BSP clearance were observed at this level. No gross pathological changes were observed and no microscopic changes were observed in the liver or other tissues examined. At 0.2 mg/kg/day clinical signs (depression and inappetance) were mild but weight gain ceased after day 14. Liver function was impaired as denoted by BSP clearance and GOT levels marginally exceeded control levels. At postmortem the liver was mottled yellow and red and had a firm consistency; histologically there was bile duct proliferation, portal fibrosis and scattered foci of degenerating and necrotic hepatocytes. The response to 0.5 mg/kg/day of aflatoxin B₁ was considerably more marked. The calf was obviously depressed by day 8, adopted a hunched stance, was inappetent, icteric, and developed hematuria and bilirubinuria on day 12. The calf gained little in the first week and lost weight thereafter; BSP clearance was significantly delayed after day 3; prothrombin time and serum transaminase levels were markedly elevated. The calf died on day 14. At necropsy there was generalized icterus; the intestine and kidneys were congested and the kidney pelvis and urinary bladder contained red-brown urine. Hemorrhages were present in the mesentery and under the capsule of the spleen; the liver was uniformly yellow, firm and had slightly swollen edges. The gall bladder was enlarged 3-fold and thickened. Microscopic changes were primarily confined to the liver where bile duct proliferation without portal fibrosis was observed; severe fatty changes were present with widespread cytoplasmic vacuolization (oil-red-O positive) in the hepatocytes (Fig 5). Hepatocellular necrosis while present was not widespread. The gall bladder was denuded of epithelium; the wall
was edematous and the submucosa and muscularis were infiltrated with polymorphonuclear leucocytes and macrophages. The spleen had areas of hemorrhage and there was moderate dilatation of tubules in the kidney cortex with cloudy swelling occluding some tubules.

**Ochratoxin**—The response of calves to 4 dose levels of ochratoxin are summarized in Table 3. At 0.1 and 0.5 mg/kg/day dose levels, detectable abnormalities were limited to polyuria; weight gains were equivalent to those of control calves. Clinical depression, reduced weight gains, low urinary specific gravity and dehydration were observed at the higher two dose levels. Increased serum GOT levels were moderate at the 1.0 and marked at the 2.0 mg/kg/day dose levels between the 9th and 18th days (Fig 4). These changes and the affects on weight gain both tended to revert toward normal values by the end of the experimental period. At necropsy the kidneys were pale and there was a mild enteritis. Kidney sections contained areas of mild tubular degeneration; there were considerable quantities of eosinophilic, hyaline material resembling protein deposited in the tubule and Bowman's capsule (Fig 6a). There was evidence of degeneration and scattered cellular necrosis of the proximal convoluted tubular epithelium and interstitial fibrosis in the latter 2 calves (Fig 6b).

**Rubratoxin**—The response of calves to 3 dose levels of rubratoxin are summarized in Table 4. Clinical signs were minimal at the 8.0 mg/kg/day level; detectable change was limited to substantial delay in BSP clearance observed from day 3 on. At the 12.0 mg/kg level depression was clinically apparent at day 5; some inappetence was noted, but weight gains were only slightly below those of the control calf. There was a marked delay in BSP clearance. At necropsy the liver was found to be mottled red and tan; the light colored areas extended into the parenchyma with no apparent lobular distribution. Histopathologic examination revealed degenerative hepatic changes with generalized cloudy swelling and occasional necrosis of single hepatocytes.

A severe clinical course was evident in the calf given 16.0 mg/kg rubratoxin. The calf became inappetant on day 1, had bloody feces on day 2 and died on day 7 before specimens for laboratory examination other than BSP clearance were obtained; this latter test revealed a substantially prolonged clearance time. At necropsy acute hepatic changes were evident; the liver was mottled, friable and the cut surface had a yellowish cast. Histopathologic examination revealed disorganization of the hepatic cords, degeneration and scattered necrosis of hepatocytes, but neither focal or zonal necrosis was observed (Fig. 7).

Combinations of aflatoxin and rubratoxin effected changes common to the two toxins given individually. The low level of combined dose produced a marked reduction in body weight while neither toxin
individually at these levels affected weight gain; this was interpreted as an interaction or synergistic response. A similar weight response was observed at the intermediate dose (0.2 mg aflatoxin and 12.0 mg rubratoxin); a tendency to recover toward normal rate of gain was observed at both of these levels. At the highest dose level weight loss was marked until the calf died at day 10. Delayed clearance of BSP followed the pattern of that for rubratoxin alone; a terminal increase in prothrombin times was observed with the high combination dose resembling qualitatively the change observed with aflatoxin alone at 0.5 mg/kg. Only modest elevations of serum GOT activity were observed at the medium and high combined doses. At necropsy of the calf dead of the high combination dose, changes included subepicardial and endocardial petechia, icterus, and a pale liver with enlarged gall bladder. Histologically fibroplasia of the portal triads was observed at the low and intermediate combined doses which caused some lobular dissection. Hepatocellular degenerative changes were widespread at the intermediate dose level while at the highest combined dose level disorganization of the hepatic cords, scattered necrotic hepatocytes and focal areas of centrolobular necrosis and congestion were observed (Fig 8a and b).

*T-2 Toxin*—The response of calves to 4 dose levels of T-2 toxin are summarized in Table 5. At all levels (0.08 through 0.64 mg/kg) some evidence of mild enteritis with loose feces was noticeable although clinically apparent signs were confined to doses of 0.16 mg/kg and above. At the two higher dose levels (0.32 and 0.64 mg/kg) an acute enteric response with bloody feces was apparent; the calves became inappetent, dehydrated and a slight to severe weight loss was observed respective to the dose level. The high dose calf developed a hunched stance and died on day 20. Clinicopathologic changes were restricted to increased prothrombin times which was marked terminally in the calf given the highest dose; increased levels of serum GOT activity were present in calves given the 2 higher doses. At necropsy abomasal ulcers were present in calves given the 2 higher doses. At necropsy abomasal ulcers were present in the calf given the 0.16 mg/kg dose and there were ruminal ulcers and abomasitis with edema in calves given the 2 higher doses. A mild enteritis was present in calves receiving the lower and intermediate doses. Histopathologically a focal suppurative rumenitis and abomasitis was observed in calves given the 2 highest doses.

**DISCUSSION**

Three of the mycotoxins used in these experiments, aflatoxin, ochratoxin and T-2 toxin, have been found in feeds and are known to cause naturally occurring cases of mycotoxicosis. The fourth toxin, rubratoxin, has not been reported in association with naturally occurring disease but has been studied extensively in the laboratory. Current methods for demonstrating rubratoxin in feeds are relatively
insensitive and are not amendable to the needs of the diagnostic laboratory. In 1971 we encountered material which we presumptively identified as rubratoxin in ground high moisture corn. The feed was associated with fatty livers and prolonged clotting times in feedlot cattle; it had visible growth of a highly toxigenic strain of *Penicillium rubum*. Material indistinguishable from rubratoxin standards was demonstrated in thin layer chromatography by the method of Hayes, et al. at levels approximating 6.5 ppm (A. C. Pier, unpublished data). Unfortunately, other confirmation of the identity of this material was not obtained. At the present time rubratoxin remains in the category of a laboratory entity with definitive evidence of its natural occurrence awaiting confirmation and better testing procedures.

The route of toxin administration (i.e., orally by capsule) was essentially normal. It was chosen over spurious routes such as intramuscular, intraperitoneal or intravascular injection as it introduced the toxins in exact amounts directly into the enteric canal as would a contaminated feed. However, T-2 toxin is known to exert necrotizing effects on the skin and oral mucosa when contaminated feed contacts these parts. Obviously the use of capsules by-passed this initial exposure, obviated interactions with saliva and prohibited early absorption in the upper digestive tract.

Minimal doses of these mycotoxins which produced definitive effects on weight gain or clinical signs within the 30 day exposure period were: 0.2 mg/kg/day aflatoxin B₁, 1.0 mg/kg/day ochratoxin A, 12.0 mg/kg/day rubratoxin and .032 mg/kg/day T-2 toxin. Combination of aflatoxin and rubratoxin at 0.1 and 8.0 mg/kg/day also effected a definitive weight response which neither toxin did alone at these levels. The effects of aflatoxin on weight gain agreed closely with those observed by Lynch, et al.¹⁵

Major effects of aflatoxin and rubratoxin were largely confined to the liver; each toxin caused death apparently by acute hepatic failure yet the action on the liver appeared to be different. Aflatoxin caused icterus, gall bladder enlargement and extensive hepatic cell necrosis at higher dose levels; a dose related response was observed in BSP clearance, prothrombin time, serum GOT levels, and body weight. Rubratoxin alone did not produce icterus or enlargement of the gall bladder. It produced relatively widespread degenerative changes of hepatic cells but little hepatic cell necrosis. Substantial rises in BSP clearance time were seen at all levels but prothrombin times and serum GOT levels were not affected.

Ochratoxin did not cause acute clinical disease at the doses tested but it did clearly cause diminished weight gains, nephropathy and enteritis. While high levels of ochratoxin effected changes in both prothrombin time and serum GOT, no evidence of liver pathology was observed and the changes noted in these clinicopathologic parameters were attributed to changes in other organs such as the kidney.
and small intestine. Several of the effects of ochratoxin (e.g., weight gain, serum GOT activity, and prothrombin time) were biphasic; that is they tended to recover later in the experiment. Recovery tendency was also noted with rubratoxin (e.g., body weight) but this tendency with rubratoxin has been reported previously in laboratory animals where it was thought to be a manifestation of tolerance. The recovery tendency with ochratoxin also might indicate the development of tolerance, however, a recent report has indicated \textit{in vitro} evidence of degradation of ochratoxin A by rumen content of an adult cow. Our calves were between 2 and 3 months of age and had been on a roughage containing diet for 1 month by the end of the experimental period. Therefore, the recovery from the effects of ochratoxin in our calves might be associated with the developing competence of their rumens.

As with ochratoxin, changes in prothrombin time and serum GOT in calves given T-2 toxin were not associated with demonstrable changes in the liver but were attributed to changes in other tissues, namely the gut. T-2 toxin is reported to cause necrosis of epidermal and mucosal surfaces, depress hematopoiesis and cause disease episodes featuring massive hemorrhagic lesions. In calves we observed epithelial necrosis but depressions of leucocyte count and massive hemorrhagic lesions were not observed. Perhaps this too is a difference peculiar to the ruminant.

A key question in such an experiment is: "Are the dose levels realistic?" Calculations of the quantity of feed a 50 kg calf would need to consume to reach these dose levels if the feed contained mycotoxin at one of the high levels already found in nature are as follows: A 50 kg calf would have to eat 0.05 kg of corn containing 101 ppm aflatoxin to reach the 0.1 mg/kg dose and 0.25 kg to reach the 0.5 mg/kg dose; with ochratoxin at 27 ppm in barley, a 50 kg calf would have to eat 0.18 kg to reach the 0.1 mg/kg dose and 3.6 kg to reach the 2.0 mg/kg dose; with T-2 toxin at 2 ppm in corn the 50 kg calf would have to eat 2 kg to reach the 0.08 mg/kg dose and 16 kg to reach the 0.64 mg/kg dose; and with rubratoxin at 6.5 ppm (as presumptively identified), the 50 kg calf would have to eat 61 kg and 122 kg to reach the 8.0 and 16.0 mg/kg doses respectively. Obviously achieving the rubratoxin level from such a feed are impossible and reaching the highest dose of T-2 toxin would be improbable under field conditions at the presently recognized high levels. However, the doses of aflatoxin, ochratoxin and lower doses of T-2 toxin could easily be achieved.
## Table 1--Treatment of Calves with Selected Mycotoxins

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</tr>
<tr>
<td>33</td>
<td>56</td>
<td>None</td>
<td></td>
<td>31</td>
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<tr>
<td>85</td>
<td>33</td>
<td>None</td>
<td></td>
<td>30</td>
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</tbody>
</table>

*Died before end of scheduled treatment.*
### RESPONSE OF CALVES TO AFLATOXIN

<table>
<thead>
<tr>
<th>Dose (mg/kg/day)</th>
<th>Duration (Days)</th>
<th>Clinical Signs (Day)</th>
<th>Wt. gain</th>
<th>Pathology</th>
<th>BSP (T 1/2)</th>
<th>Prothrom. (Sec)</th>
<th>GOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>30</td>
<td>N</td>
<td>N</td>
<td>($$) HEPATIC DEGEN., FAT, NECROSIS, FIBROSIS</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>0.2</td>
<td>32</td>
<td>MILD DEPRESSION INAPPETENCE</td>
<td>($$)</td>
<td></td>
<td>N</td>
<td>N</td>
<td>($)</td>
</tr>
<tr>
<td>0.5</td>
<td>14*</td>
<td>DEPRESSION (8)</td>
<td></td>
<td>ICTERUS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>HEMATURIA (12)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>HUNCHED STANCE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Died

**N** = Normal

$$ = Decreased

$$ = Increased

( ) = Marginal Response

Table 2.

### RESPONSE OF CALVES TO OCHRATOXIN

<table>
<thead>
<tr>
<th>Dose (mg/kg/day)</th>
<th>Duration (Days)</th>
<th>Clinical Signs (Day)</th>
<th>Wt. gain</th>
<th>Pathology</th>
<th>BSP (T 1/2)</th>
<th>Prothrom. (Sec)</th>
<th>GOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>32</td>
<td>POLYURIA (19)</td>
<td>N</td>
<td>PALE KIDNEY MILD TUBULAR DEGEN. MILD ENTERITIS</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>0.5</td>
<td>30</td>
<td>POLYURIA (22)</td>
<td>N</td>
<td>&quot;</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>1.0</td>
<td>31</td>
<td>DEPRESSED (14)</td>
<td>($$)</td>
<td>&quot;</td>
<td>N</td>
<td>N</td>
<td>$$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DEHYDRATED LOW URINARY SP.GR.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>31</td>
<td>DEPRESSED (2)</td>
<td>($$)</td>
<td>&quot;</td>
<td>N</td>
<td>$$</td>
<td>$$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DEHYDRATED HUNCHED STANCE</td>
<td></td>
<td>HUNCHED STANCE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LOW URINARY SP.GR.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**N** = Normal

$$ = Decrease

$$ = Increase

( ) = Marginal Response

Table 3.
### EXPERIMENTAL MYCOTOXICOSES IN CALVES

#### RESPONSE OF CALVES TO RUBRATOXIN

<table>
<thead>
<tr>
<th>Dose (mg/kg/day)</th>
<th>Duration (Days)</th>
<th>Clinical Signs (Day)</th>
<th>Wt. Gain</th>
<th>Pathology</th>
<th>BSP (T 1/2)</th>
<th>Prothrom. (Sec)</th>
<th>GOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.0</td>
<td>30</td>
<td>Moderate depression (23)</td>
<td>N</td>
<td>Minimal</td>
<td>†</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>12.0</td>
<td>31</td>
<td>Moderate depression &amp; inappetence (5)</td>
<td>(†)</td>
<td>Hepatic degen.</td>
<td>†</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>16.0</td>
<td>7*</td>
<td>Inappetent (1) Bloody feces (2) Prostrate (6)</td>
<td>-</td>
<td>Hepatic degen. &amp; Necrosis</td>
<td>†</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Died
- = Insufficient data
N = Normal
† = Decrease
‡ = Increase
( ) = Marginal response

Table 4.

---

### RESPONSE OF CALVES TO T-2 TOXIN

<table>
<thead>
<tr>
<th>Dose (mg/kg/day)</th>
<th>Duration (Days)</th>
<th>Clinical Signs (Day)</th>
<th>Wt. Gain</th>
<th>Pathology</th>
<th>BSP (T 1/2)</th>
<th>Prothrom. (Sec)</th>
<th>GOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>.08</td>
<td>30</td>
<td>Loose feces (24)</td>
<td>N</td>
<td>Abomasitis</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>.16</td>
<td>32</td>
<td>Loose feces (12) Rough</td>
<td>N</td>
<td>Abomasal ulcers</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>0.32</td>
<td>31</td>
<td>Loose feces (2) Bloody feces (9) Inappetent Dehydr. &amp; Rough</td>
<td>(†)</td>
<td>Abomasitis Ruminal ulcers Enteritis</td>
<td>N</td>
<td>(‡)</td>
<td>†</td>
</tr>
<tr>
<td>0.64</td>
<td>20*</td>
<td>Loose feces (1) Bloody feces (7) Inappetent Rough, Dehydr. Hunched</td>
<td>†</td>
<td>Abomasitis Ruminal ulcers Enteritis</td>
<td>N</td>
<td>†</td>
<td>†</td>
</tr>
</tbody>
</table>

* Died
N = Normal
† = Decrease
‡ = Increase
( ) = Marginal response

Table 5.
Figure 1—Effects of Selected Mycotoxin Doses on Body Weight of Calves.
Figure 2—Effects of Selected Mycotoxins on Liver Function (BSP Clearance Time) in Calves.
Figure 3—Effects of Selected Mycotoxins on Prothrombin Time (Quick) in Calves.
Figure 4—Effects of Selected Mycotoxins in Serum GOT Levels in Calves.
Figure 5—A section of liver from the calf given 0.5 mg of aflatoxin/kg of body weight/day. There was widespread vacuolation of hepatocytes and numerous degenerating and necrotic hepatocytes were present. The material in the vacuolated cells stained with oil-red-O. H & E X75.

Figure 6a—Section of kidney from a calf given 0.5 mg of ochatoxin/kg of body weight/day. An accumulation of homogeneous eosinophilic material is present in Bowman’s space. H & E Stain X200.
Figure 6b—Section of kidney from a calf given 2.0 mg of ochratoxin/kg of body weight/day. Necrotic cells are present in one tubule and there is interstitial fibrosis. H & E Stain X200.

Figure 7—A section of liver from the calf given 16 mg of rubratoxin/kg of body weight/day. Scattered degenerating and necrotic hepatocytes are present. H & E Stain X 200.
Figure 8a—A section of liver from the calf given 0.1 mg of aflatoxin and 8.0 mg of rubratoxin/kg of body weight/day. There is fibroplasia in the portal triads with dissection of the lobules. H & E Stain X100.

Figure 8b—A section of liver from the calf given 0.2 mg of aflatoxin and 16 mg of rubratoxin/kg of body weight/day. Around a congested central vein there are foci of necrosis and leucocytic infiltration. H & E Stain X200.
REFERENCES


THE BOVINE HERPESVIRUSES: AN OVERVIEW

Paul C. Smith, DVM

INTRODUCTION

The International Committee on the Taxonomy of Viruses has approved the family name of Herpetoviridae\(^1\) for the genera of viruses with the common characteristics recognized many years as belonging to the herpesvirus group. A herpesvirus study group of this Committee has recommended that each herpesvirus be named after the taxonomic unit—the family—to which its primary natural host belongs.\(^2\) Therefore, some of the well-known herpesviruses have been renamed to comply with these suggestions. A listing of some of the viruses of interest to veterinarians is compiled below:\(^2\)

<table>
<thead>
<tr>
<th>New Name</th>
<th>Previous Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human herpesvirus 1</td>
<td>Herpes simplex virus type 1</td>
</tr>
<tr>
<td>Human herpesvirus 2</td>
<td>Herpes simplex virus type 2</td>
</tr>
<tr>
<td>Human herpesvirus 3</td>
<td>Varicella-Zoster or Chickenpox virus</td>
</tr>
<tr>
<td>Human herpesvirus 4</td>
<td>Epstein-Barr or E. B. virus</td>
</tr>
<tr>
<td>Human herpesvirus 5</td>
<td>Cytomegalovirus</td>
</tr>
<tr>
<td>Cercopithecid herpesvirus 1</td>
<td>Monkey B Virus</td>
</tr>
<tr>
<td>Equid herpesvirus 1</td>
<td>Equine abortion or rhinopneumonitis virus</td>
</tr>
<tr>
<td>Equid herpesvirus 2</td>
<td>Cytomegalo-type virus</td>
</tr>
<tr>
<td>Equid herpesvirus 3</td>
<td>Coital-exanthema virus</td>
</tr>
<tr>
<td>Pig herpesvirus 1</td>
<td>Pseudorabies virus</td>
</tr>
<tr>
<td>Pig herpesvirus 2</td>
<td>Inclusion body rhinitis virus</td>
</tr>
<tr>
<td>Canine herpesvirus 1</td>
<td>Canine herpesvirus</td>
</tr>
<tr>
<td>Feline herpesvirus 1</td>
<td>Feline rhinotracheitis virus</td>
</tr>
<tr>
<td>Bovid herpesvirus 1</td>
<td>Infectious bovine rhinotracheitis (IBR)</td>
</tr>
<tr>
<td>Bovid herpesvirus 2</td>
<td>Bovine mammillitis virus</td>
</tr>
<tr>
<td>Bovid herpesvirus 3</td>
<td>Malignant catarrhal fever virus</td>
</tr>
<tr>
<td>Bovid herpesvirus 4</td>
<td>Progressive pneumonia of sheep</td>
</tr>
</tbody>
</table>

The biochemical, biological and morphological characteristics of the herpesvirus group are fairly well defined and are expressed in the cryptogram of human herpesvirus 1 \([D/2 : 80-100/7 : S/S / V/0]\). The biological properties of a nucleic acid replicative cycle in the nucleus, membrane acquisition principally at the nuclear membrane level, and the ability to establish latent or chronic infections of cells are similar for the entire group.\(^4\) The virion is a large (100-150 nm), enveloped particle with an icosahedral capsid consisting of 162 capso-
mers arranged around a single molecule of double stranded deoxyribonucleic acid (DNA) with a molecular weight of 80-100 Daltons.

Electron microscopy of ultrathin sections and negatively stained preparations reveal an inner core (25-30 nm) composed of DNA and protein, an inner protein capsid (8-10 nm), a middle protein capsid (15 nm), an outer protein capsid (12.5 nm) consisting of 162 capsomeres, an inner envelope (10 nm) and an outer lipoprotein envelope 20 nm thick. Veterinary virologists have recently shown a renewed interest in the bovine herpesvirus group. The role of cell-mediated immunity in resistance to IBR infection, the chemical recrudescence of chronic IBR infections with injectable corticosteroids, the isolation of bovine mammillitis virus from clinical outbreaks of disease in cattle in the United States, and the many isolations of other bovine herpesviruses from diseased and healthy animal tissues has created a flurry of activity in the scientific community. Therefore, it seems appropriate to review our knowledge of the bovine herpesviruses.

**Bovid Herpesvirus 1: Infectious Bovine Rhinotracheitis (IBR)/Infectious Vulvovaginitis (IPV), (IBR/IPV), Red Nose Virus.**

**Respiratory Disease.**—Disease of the respiratory tract of cattle due to herpesvirus (IBR) infections was first noticed in California and Colorado in the early 1950's. Since that time it has been shown to be worldwide in its distribution. The respiratory form is usually described as an acute necrotic rhinotracheitis. Though the frequency and severity of feed lot outbreaks of the disease seems to have been reduced somewhat by the widespread use of modified live-virus vaccines, the syndrome still occurs in the respiratory disease complex of vaccinated and unvaccinated cattle. The route of entry of the virus into the animal is generally agreed to be by the respiratory tract. The incubation period from entry to overt disease varies from 2-7 days depending upon the dose of infectious virus. Clinical symptoms are characterized by a sudden onset of hyperthermia, anorexia and depression. The severe inflammation of the epithelial surfaces of the respiratory membranes often progresses to a severe necrotic rhinotracheitis with necrotic plaques ranging in size from 1 cm to extensive sloughing of the mucosal surfaces from the anterior nares to the distal 1/3 of the trachea. Hyperemia of the muzzle, which has led to the term “red nose” often leads to a fairly characteristic crustiness of the muzzle. As with most herpesviruses, the infection of cattle with IBR virus leads to a wide range of different disease entities.

**Conjunctivitis.**—Keratoconjunctivitis, usually without ulceration, is manifested by a copious serous discharge, extensive hyperemia and edema of the conjunctiva. Frequently in natural outbreaks of the respiratory form of the disease, conjunctivitis will also be prominent; however, either syndrome may predominate and the other be virtually absent. In respiratory or generalized infections the virus...
may occasionally be isolated from almost any internal organ or so-
matic tissue but it appears to have an affinity for tissues of the
upper respiratory tract and related lymphatic tissue.

Infectious Pustular Vulvovaginitis.—Infectious pustular vulvo-
vaginitis (IPV) and balanoposthitis characterized by hyperemia of
the vulvo-vaginal and preputial mucous membranes leading to pustule
formation and ulceration is caused by a bovine herpesvirus sero-
logically indistinct from IBR virus. The spread of the disease in
naturally and artificially bred cattle poses a serious problem espe-
cially with the continued widespread use of frozen semen which
preserves the virus for long periods of time. Recently the incrimina-
tion of the virus as an etiologic agent of oophoritis and salpingitis
with resultant infertility and sterility adds to the seriousness of the
infection.\textsuperscript{21,22}

Abortions.—The role of bovid herpesvirus 1 (IBR) in bovine
abortions has been adequately reviewed recently by Durham.\textsuperscript{23} The
list of references is extensive and well chosen and should be con-
sulted by those desiring further information. Though the virus was
not recognized as an abortifacient until 1964, subsequent reports
show that it is widely recognized as a cause of abortion, stillbirths
and infertility. Most naturally occurring abortions occur between the
4th and 7th months of gestation but abortions have been reported
as early as 3 months and as late as 9 months following conception.
Respiratory disease and conjunctivitis may or may not be observed
prior to abortion. In experimental infections usually a febrile re-
response is recorded and is often followed by abortions between 18 and
30 days post infection, but longer intervals up to 60 days have been
recorded.

Meningoencephalitis.—Meningoencephalitis as a sequale to bovid
herpesvirus 1 infections has been reported by several investiga-
tors.\textsuperscript{24,25,26} Neurotropic characteristics appear to be associated with
certain isolates of bovid herpesvirus 1. Most cases of meningoen-
cephalitis occur in calves under 6 months of age. The rate of encepha-
litis may vary from an occasional\textsuperscript{26} animal to a large portion of the
herd.\textsuperscript{25} Experimental aerosol infections with non-neurotropic strains
in our laboratory have never resulted in overt cases of meningoen-
cephalitis. However, experimental infections by aerosol, intravaginal
and intracranial injection have resulted in meningoencephalitis when
a strain of virus isolated from meningoencephalitis cases was used.\textsuperscript{27}

To my knowledge no important, unequivocal serologic, morpho-
logic, or biochemical differences in these strains have been demon-
strated.

Diagnosis.—Gross changes observed at necropsy of IBR infected
animals vary from minute focal necrotic lesions of the nares, tur-
binates, epiglottis and upper \( \frac{1}{3} \) of the trachea to extensive sloughing of mucosal surfaces from these areas. Petechial to ecchymotic hemorrhages are commonly observed. Focal hemorrhage and swollen edematous lymph nodes associated with the upper respiratory tract are also common findings.

Histopathologic examination usually reveals a mononuclear infiltrate often mixed with neutrophils. A ballooning degeneration of the stratified squamous cells at the edge of the lesions is also characteristic. Intranuclear inclusions may be found occasionally in this area but should not be expected to be a constant feature.

Viral isolation and identification is the criterion for a definitive diagnosis. Seroconversions confirmed by neutralization tests are also helpful.

**Bovid Herpesvirus-2**: (BHV 2), Bovine Mamillitis Virus, Allen-Ton Virus.

An excellent review of this disease has been published recently by Cilli and Castrucci.\(^2\)\(^8\) This article cites 80 references to the disease and should be consulted for details of the general discussion given below. The disease is apparently worldwide in its distribution and has been recognized in the United States for several years\(^2\)\(^8\) even though virus isolations have been successful only recently in two outbreaks.\(^6\)\(^9\) The disease occurs in two distinct forms: (1) localized necrotic ulcerations on the skin of the teats, udder, escutcheon and perineum, and (2) generalized nodular lesions in large areas of the skin over various parts of the body. The mammary or localized form is characterized by a mild hyperthemia of little consequence but may cause serious trouble to cows in the milking line. The nursing calf may become infected and develop vesicular and ulcerative lesions on the muzzle, buccal mucosa and tongue. The lesions are characterized histopathologically by multifocal necrotic areas of the stratified squamous epithelium, ballooning—degeneration of the epithelial cells and numerous intranuclear inclusion bodies at the periphery of the lesion. A presumptive diagnosis can be made from the observance of typical lesions and the presence of intranuclear inclusions and ballooning degeneration of stratified squamous epithelial cells at the edge of the lesions when surgical biopsy specimens are examined histologically. A definitive diagnosis can be made only by isolation and identification of the virus. Acute phase and convalescent antibody evaluations are also helpful.

**Bovid Herpesvirus 3**: Malignant Catarrhal Fever Virus (MCF).

Malignant Catarrhal Fever (MCF) is an acute generalized disease of cattle and other animals. Plowright's 1968 review\(^3\)\(^0\) of the disease syndrome, etiology and pathogenesis is perhaps the most concise thesis to date and little significant scientific information has
been published since that time. The following synopsis has been taken from that article and the reader is referred there for specific references. The disease is characterized by a low morbidity but a high percentage of mortality of infected animals. Naturally infected animals have a history of contact with sheep or other philogenetically related animals such as wildebeest. Apparently, contact transmission does not occur among cattle. Clinical symptoms of infected animals are characterized by hyperthermia, depression and a copious mucopurulent exudate from the eyes and nose. Keratoconjunctivitis of a fairly peculiar type is evident. The corneal opacity begins at the periphery and extends centripetally. Progressive enlargement of the peripheral lymph nodes with lymphoreticular cell proliferation of perivascular and lymphatic tissues seems to be a constant and important criterion for histopathologic diagnosis. Severe inflammatory and degenerative lesions of the upper respiratory tract and entire alimentary tract are common. Transmission studies by Plowright and others have been consistently successful only by intravenous injection of whole blood or high titered viral suspensions grown in calf kidney cells. Plowright has been able to infect animals by other parenteral routes as well as by intranasal instillation. The etiologic agent, though rather poorly characterized, is a rather closely cell-associated herpesvirus. The appearance of isolated, patchy, cytopathic changes in cell cultures that are nonprogressive is similar to some of the changes noted with recent bovine herpesvirus isolates from cattle in the United States. High cell culture passage viral suspensions failed to immunize cattle or to significantly modify its pathogenicity. Presently there seems to be little chance of an effective vaccine being developed.

Unclassified Bovid Herpesviruses: Isolation of unclassified bovine herpesviruses from normal and diseased cattle have increased within the past few years at a phenomenal rate. Efforts to produce a high titered antibody in calves or rabbits are often unsuccessful, and techniques to evaluate the antibody present in sera of exposed animals have been less than desirable. Because of these circumstances the confusion surrounding the unclassified group of bovine herpesviruses continues unabated. Only a few of the isolation and characterization attempts are published. Some of these are discussed below.

Movar 33/63.—Bartha and colleagues in Hungary isolated a herpesvirus from tissues of a calf with respiratory disease. Experimental infections of young calves by the respiratory route failed to produce clinical disease similar to that shown by the animal from which the virus was isolated. The investigators were able to demonstrate the presence of virus neutralizing antibody in only 1 of 30 or 40 rabbits injected repeatedly with large amounts of cell culture propagated virus. The agent was not serologically related to IBR, BVM, or MCF virus.
DN-599.—A bovine herpesvirus designated DN-599 was isolated from nasal swabs taken from an 18 month old steer with clinical symptoms of respiratory disease by Mohanty and coworkers at the University of Maryland. They reported that experimental infections via the respiratory route caused overt respiratory disease in young calves. In these and subsequent experiments calves were readily infected, secreted virus in nasal secretions from 1-17 days but developed no detectable serum neutralizing or complement fixing antibodies. This last report indicates that 3 of 7 animals died of the disease. The report states that the virus was not neutralized by Movar 33/66 antiserum.

FTC-2 Virus.—Investigators at the National Animal Disease Center isolated a bovine herpesvirus from tissues of 4 of 10 IBR vaccinated steers from an outbreak of respiratory disease characterized by a hemorrhagic necrotizing tracheitis. The agent was of typical herpesvirus morphology and similar in many respects to the Movar 33/66 and DN-599 isolates. Subsequent experimental exposure of colostrum-deprived calves to both FTC-2 and DN-599 agents caused little or no clinical illness. Repeated injections of virus suspensions into calves, goats and rabbits elicited very little or no measurable virus neutralizing or complement-fixing antibody.

DDV-71.—A bovine herpesvirus was isolated from the uterine exudate of a dairy cow with metritis. The infected animal was one of a herd of 1800 dairy cows that had experienced an abnormal incidence of postpartum metritis. The author states that the agent was not neutralized by hyperimmune serum made against IBR virus and bovine mammillitis virus.

BH-1247 and Clark M/20.—Crandell and coworkers in Illinois have recently isolated a bovine herpesvirus from the fetal lungs of an aborted hereford fetus. The agent did not cause overt disease when inoculated into young calves. They refer to the agent as bovine herpesvirus-1247 (BH-1247). A bovine herpesvirus isolated from the pooled tissues of an aborted hereford fetus was recently supplied to us indirectly by Dr. R. E. Smith, University of Massachusetts, for identification. We have found that the agent is similar to the BH-1247 isolate in replicative cycle in cells, the cytopathogenic effect in tissue culture cells and to possess a close serologic relatedness to this isolate.

V-11, CK-54, and BPX/11.—Several isolates of bovine herpesviruses have been made from tissues taken from clinically normal cattle. There have been no indications that these agents cause overt disease when inoculated into cattle.

Recent research in our laboratory at the National Animal Disease Center has revealed several interesting findings of serologic re-
latedness and distinct serologic differences in eight of the bovine herpesviruses mentioned in this paper, and other isolates sent into our laboratory by other investigators for identification. We have modified three rather standard serologic techniques in our laboratory to enable us to group these agents. The details of the modifications of these techniques will be the subject of a subsequent report.

In our laboratory we have been able to produce high titered antibody in goats by a combination of intranasal and intratracheal exposure of goat turbinate cell culture propagated virus suspensions followed by repeated injections of the same viral suspension combined with adjuvant. After repeated injections of goats with cell culture propagated viral suspensions and adjuvant we utilized immunodiffusion in gel, virus plaque reduction-serum neutralization, and the indirect fluorescent antibody test to compare these bovine herpesvirus isolates.

Our studies on the serologic relatedness of nine of these unclassified bovine herpesviruses and the studies by Potgieter and Maré and the limited work done by others during the original characterization attempts leads to the classification suggested in Table 1. Though the agents listed in Group 1 are serologically related there appears to be several subgroup antigens that may provide a further subdivision following more intensive investigations. We have found that two of the viruses (BH-1247 and Clark M/20) are serologically distinct from the other group and are indistinct from each other. Preliminary tests also indicate that both have a serologic relatedness to Equid herpesvirus 1.

Perhaps such a suggestion is premature, but with our present knowledge of the bovine herpesviruses examined and the guidelines provided by the International Committee of Viral Nomenclature, I suggest that we now refer to the viruses listed in Group I, Table 1, as bovid herpesvirus 5 and those listed in Group II as bovid herpesvirus 6. The adoption of such a suggestion would simplify the identification and prevent the development of confusion that has already begun to appear in the scientific literature, such as the designation of a specific acronym developed by another investigator to a new isolate.
Table 1. Serologic Relatedness of Previously Ungrouped Bovine Herpesviruses

<table>
<thead>
<tr>
<th>Group I: Bovid Herpesvirus 5</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movar 33/63</td>
<td>Bartha, 10</td>
</tr>
<tr>
<td>DN-599</td>
<td>Mohanty, 11</td>
</tr>
<tr>
<td>FTC-2</td>
<td>Smith, 12</td>
</tr>
<tr>
<td>DDV-71</td>
<td>Parks, 13</td>
</tr>
<tr>
<td>V-11</td>
<td>Van Der Maaten, 14</td>
</tr>
<tr>
<td>CK-54</td>
<td>Luther, 16</td>
</tr>
<tr>
<td>BPX/11</td>
<td>Belak, 15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group II: Bovid Herpesvirus 6</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH-1247</td>
<td>Crandall, 33</td>
</tr>
<tr>
<td>Clark M/20</td>
<td>Smith*</td>
</tr>
</tbody>
</table>

*Personal Communication
REFERENCES

32. Bartha, A. M. (Personal Communication)
36. Smith, R. E., University of Massachusetts (Personal Communication)
37. Reid, D. E. Veterinary Medical Research Institute, Ames, Iowa (Personal Communication)
CURRENT STATUS OF IBR-IPV VIRUS INFECTION IN BULLS

R. D. Schultz, PhD; C. E. Hall, DVM; B. E. Sheffy, PhD; R. F. Kahrs, DVM, PhD and B. H. Bean

ACKNOWLEDGMENTS

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INTRODUCTION

The bovine herpes viruses (BHV) including infectious bovine rhinotracheitis virus (IBR) and infectious pustular vulovaginitis virus (IPV) are known to cause respiratory and genital tract infections in susceptible cattle of all ages. The classic respiratory infection is characterized by discrete pustules or plaques found on the mucosal surfaces, hyperemia of nasal turbinates, nasal discharge, febrile response, rapid respiration, dyspnea and occasional conjunctivitis (1,5,7,8,12,13).

Infection of the genital tract results in balanoposthitis in the bull and infectious pustular vulovaginitis (coital exanthema) in the female. These infections, like the respiratory infections, are characterized by pustules or plaques on the penis and prepuce or the vulva of the infected animal. The lesions can persist for several days to more than a week. Frequently the penis will be red and painful and the vagina may have an exudate and the animal will demonstrate pain and frequent urination (9,10,13,14,21). Respiratory infections are rarely associated with genital forms of the disease and genital forms of the disease only occasionally associated with respiratory disease. This observation has led some to believe that slight but significant differences exist between the viruses that infect the respiratory tract and those that infect the genital tract. Also it has been demonstrated with neutralization kinetic tests and low affinity antibody that serologic differences may exist for the strains of viruses we collectively refer to as IBR (15).

BHV infections of cattle present a unique problem in that after primary respiratory or genital infection animals remain latently infected, presumably for life. Latent virus can sporadically be reactivated by natural mechanisms or can be consistently reactivated by treatment with ACTH or corticosteroids (2,5,18,19,21,27). In the
case of the bull used for semen production, the potential for viral reactivation presents a special problem since semen can be contaminated with large quantities of IBR-IPV virus (2,18,21,27). Shedding can occur in animals which are clinically healthy in that reactivation of virus in latently infected animals results in mild or no clinically apparent disease, presumably because of the presence of host immune factors like antibody. The recognition of clinical signs of disease will, therefore, be of little or no value in preventing virus-contaminated semen from being included in the semen pool for distribution and sale. Virus-contaminated semen presents a potential threat to the cattle population in that IBR-IPV virus can cause infectious pustular vulvovaginitis, endometritis, salpingitis and shortened estrous cycles in susceptible cattle (9,11,14). Spread of the virus to susceptible pregnant cattle in the herd can lead to abortions and infection of susceptible neonates could potentially lead to a fatal septicemic disease (3,6,16,28). Because of the threat to the cattle population some have advocated maintaining and collecting only bulls that are serologically negative for IBR virus.

Because of the potential hazards from IBR-IPV virus contaminated semen we have been involved in: (1) determining conditions which result in reactivation of virus after primary infection; (2) developing and testing numerous types of IBR vaccines with an aim at preventing genital infection or genital shedding of virus; (3) examining the effect of virus contaminated semen on reproductive performance and disease of the female; (4) developing sensitive and accurate techniques to detect virus in semen; (5) developing tests to distinguish between vaccine strains and wild virus; and (6) determining the role serologically positive and serologically negative bulls play in the transmission of IBR virus.

This report summarizes results of studies in each of these areas and offers recommendations to assure that semen is free of significant quantities of IBR-IPV virus.

Reactivation of IBR-IPV Virus

Several reports have appeared on natural reactivation and shedding of IBR virus in semen for periods up to one year after initial primary infection (2,21). Experiments have demonstrated consistent and repeated shedding of virus after ACTH and corticosteroid treatment of cattle in which primary infection occurred months or years prior to treatment (2,5,18,19). IBR virus appears to be more readily reactivated by corticosteroid than the herpes viruses of other species. Furthermore, we have recognized on rare occasion, reactivation of IBR virus at parturition, presumably as a result of elevation of endogenous steroid and reactivation of the virus with febrile responses associated with viral or bacterial infections or neoplastic disease.
Natural reactivation associated with the above conditions has been assumed because virus was isolated and/or marked increases in viral neutralizing antibody titer occurred. The usual therapeutic doses of corticosteroid used topically or系统ically should not lead to reactivation of the virus because the dose is too low and duration of treatment too short. However, treatment with an equivalent of 10 mg or higher of dexamethasone for three days or longer would in general be expected to cause viral reactivation. The mechanism of viral reactivation is not known, however, the immunosuppressive effect of steroid, particularly on the T cells may contribute to replication of the virus (4). It would appear that low levels of neutralizing antibody allow the exteriorization and shedding of the virus, therefore, maintenance of high antibody titers is recommended (22).

Caution should be exercised in attempting to recognize viral shedding by appearance of clinical signs of disease, since they may be mild or nonexistent. Therefore, the potential for viral reactivation is always present if serologically positive bulls are maintained. However, a well managed low stress situation greatly reduces the likelihood of reactivation of the virus.

RECOMMENDATIONS

Do not collect semen from a bull with clinical signs of respiratory or genital IBR-IPV infection. Do not treat serologically positive bulls with corticosteroid preparations that could activate the latent virus. Exercise extreme caution in collecting bulls that are febrile for more than three days. Maintain a low-stress management situation at all times.

Vaccination Studies

Numerous questions need to be considered when testing vaccines for their efficacy and safety. Special considerations need to be given to vaccination of bulls because of the potential for: viral shedding in the semen, the effect vaccination may have on reproductive performance, semen quality and the potential for reactivation of the vaccine virus. The obvious safety features of a killed viral vaccine led to early studies with inactivated virus vaccine (17,22). Inactivated viral vaccine administered in two or more doses resulted in viral neutralization titers similar to titers after live viral vaccine or after inapparent natural infection. However, bulls challenged with virulent virus did not develop signs of clinical disease but they did become latently infected and when later treated with corticosteroid, virus was reactivated and isolated from nasal secretions and the genital tract (20). Therefore, it was suggested that killed IBR virus vaccine was not effective in preventing infection and development of the latent carrier state (Sheffy et al., manuscript in preparation). Vac-
cination with intramuscular vaccines led to latent infection and after steroid treatment virus was isolated from the respiratory and genital tracts (18,20). The intramuscular vaccine viruses have been demonstrated to cause death and abortion of inoculated fetuses (see section on "Cornell Fetal Test") similar to wild virus. Therefore we consider them unsafe and cannot recommend vaccinating bulls with intramuscular vaccine.

An intranasal vaccine for IBR and bovine parainfluenza-3 (BPI-3) has been described (24,25,26). Vaccination with an intranasal IBR and BPI-3 vaccine (Nasalgen IP) provided results suggesting this vaccine virus may be both safe and efficacious for bulls. Serologically negative bulls were vaccinated intranasally, or intranasally and intrapreputially, with Nasalgen IP. Virus was isolated from the respiratory tract for periods up to 12 days after intranasal vaccination, however, virus was not isolated from the prepuce or the semen at any time after intranasal or intrapreputial vaccination. Steroid treatment of these bulls did not cause virus to be shed from the prepuce or respiratory tract suggesting that the virus did not become latent or virus is not readily reactivated with the corticosteroid regimen used to reactivate intramuscular vaccine virus or wild virus.

Since intrapreputial vaccination did not result in genital tract infection as determined by the inability to reisolate virus shortly after vaccination, and it did not produce an increase in immunoglobulin or specific antibody in the prepuceal washings, intrapreputial vaccination was discontinued. Bulls vaccinated intranasally were divided into three groups. The first group consisted of 9, the second 10, and the third 9 bulls. Bulls in group I were challenged intranasally with virulent virus one month after vaccination, bulls in group II were challenged intranasally and intravenously 3 months after vaccination, and bulls in group III were challenged intranasally and intravenously 6 months after vaccination with $1 \times 10^{6.5}$ TCID$_{50}$ of virulent virus. Virus was not isolated from the prepuce during a two week period following viral challenge in any of the three groups of bulls. One month after viral challenge 6 bulls from group I, and all the bulls in groups II and III were treated with corticosteroid. Virus was not isolated from the prepuce of bulls in group I or group II, but was isolated from the prepuce of two bulls in group III, suggesting that protection against reinfection persisted for at least three months but for less than six months.

A limited number of intranasally vaccinated bulls were challenged intrapreputially with $1 \times 10^7$ IPV virus. Animals were resistant to challenge in that no virus replication could be determined, as demonstrated by an inability to isolate virus 7 days post challenge, and no clinical signs developed.

Our experience for the past two years with intranasal vaccination
in a stud of approximately 300 bulls, indicates that there are no complications associated with the frequent vaccination, antibody titers are being maintained, and virus is not being shed in the semen. (See section on "Cornell Semen Tests."

New bulls are vaccinated when they enter the stud. Older bulls that were serologically positive as a result of infection with virulent virus are also vaccinated, however, a small number of these bulls have been demonstrated to shed virus in the semen for short periods after experimental steroid treatment, but have not been demonstrated to shed virus under normal conditions of low-stress management in the stud.

RECOMMENDATIONS

If vaccination is deemed necessary, administer an intranasal vaccine (Nasalgen IP) every 4 to 6 months.

Effect of Virus Contaminated Semen on Reproduction

The effects that virus contaminated semen will have on the female are influenced by at least three factors: 1) the amount of virus in the semen; 2) the strain of virus; 3) the immunologic status of the female.

A number of studies have demonstrated that semen can contain viral doses adequate to cause severe vaginitis, endometritis, salpingitis and shortened estrous cycles in serologically susceptible females (11,14,27). Similar effects may also be seen in serologically positive females (I. M. Parsonson, personal communication).

Studies on the other hand, with small quantities of virus <200 TCID$_{50}$ in the semen, indicate that neither serologically negative nor serologically positive heifers were adversely affected (Sheffy, B. E., Hall, C. E., Schultz, R. D., in preparation). Of 25 serologically negative heifers, 19 remained serologically negative after breeding with contaminated semen. A majority conceived after the first breeding and the others after the second or third breeding. Six heifers developed minimal lesions on the vaginal mucosa and virus was shed from the vaginal tract in all six animals and from the respiratory tract in one of the six animals. Six heifers developed antibody to IBR by 14 days post insemination. One of the six conceived after the first breeding, four of the six after the second breeding and the sixth animal required five services before it settled. One animal in this group aborted, was rebred and had a normal fetus that she carried until slaughtered at 150 days. Of the nine serologically positive heifers included in the study, none developed clinical signs of IPV, six heifers conceived after the first breeding and all conceived after
three attempts at breeding. Length of period between estrous was normal for the 34 heifers.

Strain differences for IBR-IPV may lead to certain strains causing more severe genital disease than others. In a limited number of serologically susceptible bulls and heifers, inoculation of the prepuce or vagina with JSAV-IBR (Nasalgen IP) did not cause clinical signs of balanoposthitis nor infectious pustular vulvovaginitis. Therefore, semen contaminated with this vaccine virus would presumably have little or no potential for producing disease.

Virus contaminated semen would be expected to have a less serious effect on immune animals than susceptible animals, however, results of I. M. Parsonson (personal communication) would suggest that immune animals inseminated with viral contaminated semen have sequelae similar to susceptible animals.

**RECOMMENDATION**

Do not inseminate cattle with semen containing IBR virus that can be detected by the Cornell Semen Tests (see next section).

**Cornell Semen Tests**

We have developed an *in vitro* and *in vivo* test to detect viral contaminated semen (20).

The *in vitro* test is best used with single ejaculates or pooled ejaculates from the same bull and can be used with raw or extended semen. Because seminal plasma and sperm are toxic for cell cultures, the seminal plasma is treated with trypsin inhibitor which reduces, but does not always eliminate, the toxicity. The sample is then tested by a standard virus isolation procedure (20).

The *in vivo* (animal) semen test utilizes pooled semen samples and requires IBR serologically negative calves. Semen samples (0.1 ml raw semen from each ejaculate) are pooled daily and stored in liquid nitrogen. Daily samples are pooled at the end of the week. One-half the total volume of semen is inoculated intranasally and the other intravenously into an IBR susceptible calf. Serum samples collected at the time of inoculation and 3 and 5 weeks later are tested for neutralizing antibody. Animals are arbitrarily used twice for this test. The advantage of the animal test is the ability to pool samples without reducing the sensitivity. Pooling samples also results in a marked reduction in the cost of the test. A significant disadvantage is that unless there is a low frequency of positive samples, extensive rechecking of individual samples will be required to determine which bull is shedding virus.

In an attempt to modify the test to use an animal other than
cattle; goats, ferrets, rabbits, guinea pigs, rats, hamsters, and mice were inoculated intranasally with 200 TCID$_{50}$ of IBR or intravenously with 200 TCID$_{50}$ of IPV, a dose of virus found to cause infection in susceptible cattle. Only cattle were susceptible to infection with this amount of virus as determined by the development of serum neutralizing antibody. Therefore, the animal test must employ cattle if sensitivity is to be maintained.

Employing both of the "Cornell Semen Tests" we have examined more than 6,000 semen samples from bulls with natural IBR infection and/or bulls vaccinated with Nasalgen.

**Comparison of the Cornell Semen Tests**

<table>
<thead>
<tr>
<th></th>
<th>In Vitro</th>
<th>In Vivo</th>
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<tbody>
<tr>
<td>Cost/ejaculate$^a$</td>
<td>$10.00-$$15.00</td>
<td>$1.50-$$3.00</td>
</tr>
<tr>
<td>Time for results</td>
<td>3 to 4 weeks</td>
<td>4 to 5 weeks</td>
</tr>
<tr>
<td>Virus sensitivity (TCID$_{50}$)</td>
<td>Requires $5 \times 10^3$ to $5 \times 10^5$/ml raw semen</td>
<td>$1 \times 10^3$ to $5 \times 10^3$/ml raw semen</td>
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<tr>
<td>Sample volume required</td>
<td>0.5 ml semen</td>
<td>0.1 ml semen</td>
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<tr>
<td>Total sample that can be tested</td>
<td>0.1 ml/tube</td>
<td>30-40 ml/animal</td>
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<tr>
<td>Use extended or raw</td>
<td>Both</td>
<td>Both</td>
</tr>
<tr>
<td>Animal required</td>
<td>None</td>
<td>Susceptible calves</td>
</tr>
<tr>
<td>Special provisions &amp; equipment</td>
<td>Tissue culture equipment &amp; techniques</td>
<td>Isolation or barn facility tissue culture facility</td>
</tr>
<tr>
<td>Ability to detect other viruses</td>
<td>All CPE viruses</td>
<td>Within limits of sensitivity—all viruses if susceptible animals are employed.</td>
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$^a$Cost for the *in vitro* test is based on individual ejaculates of a single bull to maintain sensitivity, and cost for the *in vivo* test is based on a pool of 50 ejaculates since sensitivity is not affected by pooling.

**RECOMMENDATION**

If small numbers of individual ejaculates are to be tested (i.e., for export) use the *in vitro* test. If large numbers of pooled ejaculates need to be tested, use the *in vivo* (animal) test.

**Cornell Fetal Test**

Currently few or no methods are available to differentiate between virulent and attenuated IBR viruses. This results from the fact that *in vitro* characteristics of virulent and vaccine viruses are similar or identical. One notable exception is the temperature sensitive mutant of IBR virus recently used in an intranasal vaccine. *In vivo* characteristics of certain vaccine strains and virulent virus are similar in that intranasal challenge with virulent virus and intramuscular vaccine can lead to either inapparent infection or mild disease, and rarely does severe infection develop. Because of the lack
of markers we decided to use fetal inoculation as a method to distinguish less attenuated vaccine or wild virus from more attenuated vaccine viruses.

Fetal inoculation with several intramuscular vaccines and with wild virus resulted in fetal death and abortion 9 to 19 days post inoculation regardless of the age of the fetus. If abortions occur during the first three days after surgery they are considered to be due to the surgical manipulation rather than the virus.

Unlike intramuscular vaccine and wild virus, fetuses 90 days or older inoculated with Nasalgen IP or JSAV-IBR alone, survived infection and some developed humoral and cellular immunity to IBR virus.

The Fetal Test has been used to determine the virulence of numerous intranasal vaccines, field isolates and viruses present in the semen or prepuce of experimentally infected or vaccinated bulls which have been steroid stressed in certain of the studies described previously in this paper.

RECOMMENDATION

This test should be used to distinguish between virulent and attenuated strains of IBR virus.

Role of Bulls in the Transmission of Infectious Bovine Rhinotracheitis Virus

Attempts to maintain a serologically negative stud will eventually fail because the large number of serologically positive bulls dictates eventual acquisition of an actively or latently infected animal. Also the virus could be introduced by man. Excluding IBR positive bulls could also result in a loss of outstanding genetic potential. Furthermore, virus contaminated semen could be collected from serologically negative bulls if the following conditions are present:

1. Susceptible animals actively infected and shedding virus before antibody development.
2. Animals with low titers could be recorded as negative in an insensitive serologic test used to detect antibody.
3. Some infected animals may develop a cellular immune response without measurable humoral (neutralizing antibody) response.

The likelihood of each of these is low but cases of each have been recognized during this study.

In an attempt to determine the role serologically IBR-IPV positive bulls play in the transmission of IBR-IPV virus we have ex-
amined more than 6,000 semen samples over the past 21/2 years, including samples collected during the time of inapparent infection. In a cooperative study more than 4,000 additional ejaculates were tested independently in a second laboratory and the results of that study are similar to those presented here (Kahrs, R. F., Schultz, R. D. and Bean, B. H. 1976. Epidemiologic Considerations Regarding the Detection of IBR Virus in Bovine Semen. Proceedings of Veterinary Laboratory Diagnosticians Meeting, Miami, Florida).

CONCLUSION

IBR virus reactivation and shedding is a potential threat when serologically positive bulls are used for production of semen. However, after testing more than 10,000 ejaculates for more than 21/2 years, from approximately 250 bulls that developed a mild or inapparent respiratory infection with IBR and that have been vaccinated every four months with Nasalgen IP, we conclude that there is NO reason to suspect these bulls transmitted IBR-IPV virus.

REFERENCES


Dr. Joe Bearden presented a Subcommittee Report and a Resolution to be included in the minutes of the Infectious Disease of Cattle Committee. The report is as follows:

On February 3, 1976, the Southern Division of the American Dairy Science Association, assembled for its Annual Business Meeting in Mobile, Alabama, passed the following resolution without opposition:

That the Southern Division of ADSA go on record as supporting the proposed regulations and to ask USDA to publish them in the Federal Register—

On June 22, 1976, the American Dairy Science Association, assembled for its Annual Business Meeting at North Carolina State University, passed a resolution, without opposition, calling upon the Animal and Plant Health Inspection Service to immediately publish in the Federal Register revised proposed regulations governing interstate movement of bovine semen, and after due process, implement these regulations.

During the year two points have been raised to members of the Subcommittee that deserve additional attention.

1. The last draft of the proposed regulation requires that records be kept so that the location of all semen can be maintained until it is used for insemination or otherwise is disposed of. This is not practical from several points of view:
   a) The expense would be prohibitive.
   b) It would tend to stifle free enterprise, particularly sales between breeders. Sales would almost be limited to semen procedures.

2. Somewhere between the first and last drafts, the section dealing with on the farm or ranch collection of semen has been reduced to the point that some fear that this provision is intentionally being phased out.
The committee recommends:

1. That the section on records be revised to include first sales only.

2. The section dealing with on the farm or ranch be expanded to remove doubt that such a provision is intended. Even though this provision will be difficult to completely enforce, without it the whole regulation would probably fail.

3. That the committee on infectious diseases of cattle ask U.S. A.H.A. to go on record supporting the immediate publication in the Federal Register the revised proposed regulations governing the interstate movement of bovine semen.

Discussion ensued as to the propriety of publishing this regulation without more discussion and as to whether various affected associations had indicated their recognition of the need for such regulations.

Dr. Bearden moved that the Subcommittee report be accepted and forwarded to APHIS for publication in the Federal Register. The motion was seconded and passed.

Dr. Ron Schultz—Cornell University
Current Status of IBR-IPV Infections in Bulls

IBR virus can remain in the bovine host for the life of the animal. Various stresses can cause periodic shedding. It can be transmitted by both respiratory and the genital tract. It can be spread in the semen of bulls. In the study, Dr. Schultz reported at this time, they were unable to demonstrate infectively through the semen. This paper is in the proceedings of the scientific program of U.S.A.H.A.

Dr. Harry Anthony—Kansas State University—Veterinary Diagnostic Laboratory
Sudden Death Syndrome of Feedlot Cattle

First noticed 8 years ago in cattle 1000 to 1200 pounds in weight. Sudden Death Syndrome is not caused by bloat, nor acidosis nor clostridial infection. Post mortem lesions are not significant. It is believed that the cause is a physiological problem in the rumen as a result of research at Kansas State University. As the concentrate in the ratio increases, the rumen liquor becomes more acid allowing gram negative organisms to grow more abundantly and believed to produce an endotoxin.

A research paper will soon be published.

Dr. Barnett presented a paper prepared by Dr. Janice Miller and Dr. M. J. Van Der Maaten.
World-wide opinion regarding the etiologic significance of bovine leukemia virus and the value of serological tests is perhaps best indicated by three statements unanimously agreed to by participants at a recent European Economic Community symposium on bovine leukosis. The three statements were:

1. Bovine leukemia virus should be officially recognized as essential in the etiology of enzootic bovine leukosis.

2. Serologic tests should be incorporated in the governmental regulations concerning enzootic bovine leukosis.

3. A positive result of a recognized serological test should be considered as an indication of the presence of specific antibody to bovine leukemia virus and as specific for disease.

The agar-gel immunodiffusion test, using a glycoprotein antigen, remains the most widely used serological test for bovine leukemia virus infection. The recent commercial availability of antigen and test kits (Pitman-Moore) virtually assures the widespread adoption of this test. This technique has been found to be equal or superior in sensitivity to a number of other tests and compares favorably with results obtained with very sensitive radioimmunoassays.

Our best estimates, based on limited testing with the glycoprotein gel diffusion test and on extrapolations from earlier surveys with less sensitive tests, would be that 21% of midwestern dairy cattle are infected with bovine leukemia virus and that some infected cattle are present in at least 66% of our dairy herds. Figures for beef herds are much lower with perhaps only 2.5% of the animals infected and infected animals present in only 7% of the herds.

On the basis of these serological surveys, and in the absence of convincing evidence of potential human health hazards, it is our opinion that conventional test and slaughter methods for the control and eradication of bovine leukemia virus are not economically justifiable. It would not seem unlikely however, that import regulations may eventually force breeding services export semen, and exporters of breeding stock, to establish bovine leukemia virus free herds. This could probably be accomplished either by serological testing and removal of reactors or, more gradually, by segregation of herds into negative and positive groups of animals. In view of these facts, it may be of value to the cattle industry if some official criteria could be established to certify herds to be bovine leukemia virus free with some provision for retesting and recertification on a periodic basis.

The authors would like a sub-committee formed to suggest regulations to proper authorities.
Pseudorabies in cattle is an acute disease that directly affects only the nervous system and skin. It causes a non-suppurative encephalitis or myelitis often without the development of either macroscopic or microscopic lesions. The morbidity equals the mortality. The morbidity may range from extremely low to 100%.

Transmission

1. May be direct inoculation through the bite of swine. Clinical signs in these cases will usually include Perineal pruriti

2. Inhalation

Diagnosis is based on:

1. Clinical signs.

2. Virus isolation or fluorescent-antibody technique on the central nervous system.

Differential diagnosis must include causes of rabies, lead poisoning or chlorinated hydro-carbon toxicities.

If control of Perineal pruritis in swine can be effective, the problem in cattle will cease to exist because cattle are a dead-end host.
EVALUATION OF THE IMMUNE RESPONSE OF CATTLE TO SINGLE AND MULTIPLE VACCINATION WITH A POLYVALENT LEPTOSPIRAL BACTERIN

D. N. Tripathy, BVSc & AH, PhD; L. E. Hanson, DVM, PhD; R. M. Nervig, DVM; M. A. Cardella, MS and M. E. Mansfield, DVM

INTRODUCTION

Leptospirosis of cattle in the United States is caused by one or more of the 6 serotypes: *L. icterohaemorrhagiae, grippotyphosa, pomona, canicola, hardjo* and *szwajizak*. Serotypes *hardjo* and *szwajizak* belong to the same serogroup, *hebdomadis*, but differ significantly in antigenicity. The other 4 serotypes belong to different serogroups. Leptospiral infections of cattle cause significant economic losses to the cattle industry and may also serve as a source of human infection. Since wildlife is a major source of leptospiral infection (with the exception of *hardjo* and *szwajizak* having been isolated only from cattle), immunization of susceptible cattle with prevalent serotypes is the only practical means of control of the disease. Both experimental and field immunizations have indicated the usefulness of vaccination (Hanson *et al.*, 1972; Diesch *et al.*, 1976; Stoenner, 1976).

During natural leptospiral infection, infected animals develop a significant positive serological response in 7 to 10 days to the infecting leptospiral serotypes as measured by the microscopic agglutination (MA) tests. The animals vaccinated with current licensed leptospiral bacterins, however, develop little or no MA antibody although presence of protective antibody (IgG)x in their sera has been demonstrated by the growth inhibition test, hamster protection test, and direct challenge of vaccinated animals (Huhn *et al.*, 1971; Negi *et al.*, 1971; Tripathy *et al.*, 1974; Tripathy *et al.*, 1975; Tripathy *et al.*, 1976).

The objectives of the present study were to (1) compare the response of cattle to single and multiple vaccination with a polyvalent bacterin with subsequent challenge to serotype *hardjo*, (2) to measure if there was any cross protection against *szwajizak*, (3) to determine if any hypersensitivity was associated with repeated vaccination and challenge.

College of Veterinary Medicine, University of Illinois, Urbana, Illinois and Veterinary Services Laboratory Animal Plant Health and Inspection Service, USDA, Ames, Iowa.

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The authors acknowledge technical assistance of Mrs. R. Marlowe, Mr. W. Manuel, Mrs. J. L. Kellogg and Miss S. L. Campbell.
MATERIAL AND METHODS

1. Cattle. Animals used in this study were Hereford grade steers of 6 to 8 months of age which were randomly divided in 3 groups of 10 each.

2. Bacterin. The vaccine was a licensed bacterin consisting of serotypes *grippotyphosa*, *pomona* and *hardjo* supplied by the Affiliated Laboratories, White Hall, Illinois.

3. Immunization. Each of the 10 animals of group 1 was inoculated with a single dose of 5 cc bacterin subcutaneously. Each of the 10 animals of group 2 were vaccinated 5 times at approximately 2 month intervals. Each animal was vaccinated with 5 cc of bacterin subcutaneously each time. Ten animals of group 3 were left as unvaccinated controls.

4. Measurement of Immune Response. MA Test. Sera from all animals obtained before vaccination and approximately at 2 month intervals were tested for the MA antibody response. Sera from 15 animals from the 3 groups were tested at weekly intervals following challenge for MA antibody. Sera showing more than 50% agglutination of leptospiral cells at a particular dilution were considered positive while those showing less than 50% agglutination at a particular dilution were considered as incomplete (I) reaction indicative of some antibody response.

5. Challenge. Fifteen animals (5 animals from each of the 3 groups) were randomly selected and challenged with serotype *hardjo*, strain 750, approximately 12 months after primary vaccination. The challenge culture of *L. hardjo* had been maintained regularly by hamster passages. The semisolid growth from the last hamster passage was transferred to 100 cc of liquid bovine albumin polysorbate 80 medium (BAP 80) to which 10 ml of semisolid medium had been added and the culture was allowed to grow for 7 days. Each animal was inoculated with 5 cc of culture intraperitoneally and 0.1cc intraocularly containing approximately $5.7 \times 10^9$ leptospires per ml.

6. Cultural Isolations. All 15 animals (5 from each group) were killed 4 weeks after challenge and kidneys from each animal were examined for gross lesions. A portion of the kidney from each animal was fixed in 10% formalin, stained with hematoxylin and eosin and was examined for histopathological changes. Another portion of the kidney was stained by Warthin Starry method for the presence of leptospires. A suspension of the kidney from each animal was cultured in liquid and semisolid BAP 80 medium (Ellinghausen and McCullough, 1965) and was also inoculated in a pair of young hamsters. The hamsters were killed 3 weeks after inoculation, their kidneys were cultured, and sera were tested for MA antibody.
IMMUNE RESPONSE OF CATTLE

7. Passive Hamster Protection Test with L. szwajizak and Hamster Protection from Infection Test (HPIT) with hardjo. (a) Sera from 5 animals of each of the 2 groups obtained 12 months after primary vaccination and 5 controls were tested for hamster protection test against szwajizak. Each of the 5 hamsters were inoculated intraperitoneally with 0.5 cc of undiluted serum from each animal. Twenty-four hours after serum inoculation, each hamster was challenged with 50 szwajizak (11904)* lethal doses$_{50}$ or 440 infective doses$_{50}$ as determined by titration. Fourteen days post challenge, one kidney from each surviving hamster was cultured for the presence of leptospires.

(b) Sera from 5 animals of each of the 2 groups obtained 12 months after primary vaccination and 5 controls were tested for HPIT with hardjo. Each of the 5 hamsters was inoculated with 0.5 cc of undiluted serum from each animal. Twenty-four hours after serum inoculation, each hamster was challenged with 37 hardjo (11601) infective doses$_{50}$ as determined by titration. Fourteen days after challenge, one kidney from each animal was cultured for leptospires in semisolid medium.

RESULTS

The results of MA antibody response following single and multiple vaccination are presented in Table 1 and the post challenge MA antibody responses of the cattle of 3 groups are presented in Table 2. Only 4 animals reacted incompletely at 1:100 with grippotyphosa in the single vaccination group 2 months after vaccination and similar activity was detected in sera of one animal for pomona 10 months after vaccination. MA antibody response of the multiple vaccination group was better than the single vaccination group as several animals had complete or incomplete 1:100 titers at various times (Table 1). Following challenge, however, sera of all animals of the 3 groups had a rise in MA antibody titer, although the response of the control group was somewhat greater than the 2 vaccinated groups. Further, the MA antibody in serum of challenged controls declined at a slower rate than in the sera of the vaccinated groups, as 4 out of 5 of the controls had titers of 1:100 while only 1 out of 5 of the single vaccination group and 3 out of 5 of the multiple vaccination group had a complete 1:100 titer 4 weeks after challenge (Table 2). None of the cattle of the single or multiple vaccination group developed any hypersensitivity reactions.

Kidneys from 2 animals of the control group showed multiple white foci on gross examination ranging from 2 to 4 mm in diameter. One animal of the single vaccination group had one small white

*Supplied to APHIS by Dr. Shenberg, Israel Institute for Biological Research, Nes-Ziona, Israel.
focus on the kidney while another animal had 2 pinpoint foci. Only one animal of the 5 of the multiple vaccinated group had a few small white foci.

Histopathologic examination of the kidneys of the vaccinated animals revealed some mild focal interstitial nephritis, while relatively more marked changes were observed in the kidneys of the control animals. Two of the control animals had focal areas of marked interstitial nephritis, periglomerular mononuclear cell infiltration hyaline casts and thickening of the basement membrane of the glomeruli (Fig. 1). Leptospires were isolated from the kidney of one control animal. Silver stained section of the kidney from the same animal by Warthin Starry method also revealed the presence of leptospires. Leptospires were not isolated from any of the 10 vaccinated animals that were challenged, although mild interstitial nephritis indicated that the challenge was active but self limiting in the vaccinated animals. Leptospires were not isolated from the hamsters that were inoculated with the kidneys of the challenged animals. None of the hamster sera had any MA antibody activity.

Protective activity against szwajizak was detected in some sera of cattle of the multiple vaccination group in hamster protection test although a majority of the hamsters (72%) had kidney infection. No hamster protection activity against szwajizak was demonstrable in single vaccination group (Table 3).

In evaluation of hardjo resistance as measured in the hamster protection studies, kidney infections were present in only 12% of the hamsters which received sera of cattle following multiple vaccination, compared to 84% infectivity for the hamsters receiving serum of cattle with a single vaccination and 96% of the control hamsters (Table 4).

DISCUSSION

Regular yearly vaccination of cattle against existing serotypes in endemic herds has considerably reduced the losses from leptospirosis and has improved the performance of cattle herds (Hanson et al., 1972). Evaluation of the effect of bacterin on the basis of immune response measured by the microscopic agglutination test alone is not adequate. Most vaccinated animals develop little or no significant MA antibody following vaccination in contrast to significant MA antibody response in natural infection or experimental exposures involving live organisms. This difference in the immune response measured by the MA test has a distinct advantage in distinguishing an immune response following vaccination from active natural infection. However, presence of protective antibody has been detectable for as long as one year after vaccination.
In the present study both single and multiple vaccination provided protection against a satisfactory *hardjo* challenge as demonstrated by no leptospiral isolations made from the vaccinated animals and one isolation made from one of the control animals. Further, characteristic kidney changes in 2 of the control animals were marked while very mild or absent in the vaccinated animals which suggested limited infections in the vaccinated groups. Similar observations were made in our previous studies (Tripathy et al., 1976).

Morter *et al.* (1963) reported anaphylactic reaction in immunized calves following inoculation intravenously with washed serum-free *L. pomona* disrupted cells. None of the cattle in the present study showed any signs of sensitization following multiple vaccination or after challenge by the intraperitoneal route.

In hamster protection test, sera from multiple vaccination group provided some protection against *szwajizak* but not from the single vaccination group. This would be expected because *hardjo* and *szwajizak* share common minor antigens as both belong to the same serogroup. Similarly, the immune response of the multiple vaccinated cattle was superior against *hardjo* in the hamster protection studies as measured by protection from infection. Huhn *et al.* (1971) detected protective antibody against *pomona* in the sera of vaccinated cattle up to one year post vaccination by the hamster protection test measured by hamster survival. However, the percentage of renal infection in hamsters was higher than the mortality with the same serum. The serum from cattle showed the greatest protection 2 months following vaccination and a gradual decline thereafter.

**SUMMARY**

Microscopic agglutinating antibody titers of the cattle of the 2 groups did not indicate adequate response for evaluation. Both vaccinated and control animals showed significant MA antibody response following challenge, indicating adequate exposure, although the titers of the control animals were higher and remaining for longer periods. Leptospires were isolated from one of the control animals and from none of the vaccinated cattle. Histopathologic changes were more marked in 2 of the control animals indicative of active infection. Some protection against *szwajizak* was detected in sera of multiple vaccination group when tested by hamster protection test but none in the single vaccination group. In hamster protection from infection test (HPIT) for *hardjo*, considerably more protection was detected in the multiple vaccination group than the single vaccination group. None of the vaccinated or control animals revealed any hypersensitive reaction to leptospiral antigen.
<table>
<thead>
<tr>
<th>Group</th>
<th>Vaccination</th>
<th>Antibody response against</th>
<th>Before vaccination</th>
<th>At intervals after primary vaccination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 months</td>
<td>4 months</td>
</tr>
<tr>
<td>1</td>
<td>Single</td>
<td>grippe-typhosa</td>
<td></td>
<td>4 I 1:100</td>
</tr>
<tr>
<td></td>
<td>(n=10)</td>
<td>hardjo</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pomona</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Multiple</td>
<td>grippe-typhosa</td>
<td></td>
<td>4 I 1:100</td>
</tr>
<tr>
<td></td>
<td>(n=10)</td>
<td>hardjo</td>
<td>0</td>
<td>2 I 1:100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pomona</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>None</td>
<td>grippe-typhosa</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(n=10)</td>
<td>hardjo</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pomona</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

n = No. of cattle in each group

I = Incomplete reaction at 1:100 dilution where less than 50% of the leptospires are agglutinated. The number before 'I' represents the animals showing incomplete MA reaction at 1:100 dilution. The number without 'I' represents the number of animals with a complete 1:100 MA titer where 50% or more leptospires are agglutinated.
## Table 2

**Microscopic Agglutinating Antibody Response of Cattle Against Hardjo Following Challenge with *L. Hardjo***

<table>
<thead>
<tr>
<th>Group</th>
<th>Vaccination</th>
<th>Before challenge</th>
<th>Weekly post challenge MA antibody response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 week</td>
</tr>
<tr>
<td>1</td>
<td>Single (n=5)</td>
<td>5 (N)</td>
<td>1  1:100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 (N)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Multiple (n=5)</td>
<td>3  1:100</td>
<td>2  1:100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 (N)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>None (n=5)</td>
<td>5  1:100</td>
<td>3  1:100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Controls (n=5)</td>
<td>2  (N)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- I = Incomplete reaction represented by less than 50% agglutination at 1:100 dilution
- N = Negative
- n = No. of cattle in each group

## Table 3

**Hamster Protection Test with Sera from Cattle Vaccinated with Polyvalent (Grippotyphosa, Hardjo and Pomona) Bacterin and Nonvaccinated Controls Tested Against *L. Szwajizak***

<table>
<thead>
<tr>
<th>Group</th>
<th>Vaccination</th>
<th>Average MA titer</th>
<th>% survival</th>
<th>% infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Single (n=5)</td>
<td>2.4</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>Multiple (n=5)</td>
<td>9.6</td>
<td>32</td>
<td>72</td>
</tr>
<tr>
<td>3</td>
<td>None (controls)</td>
<td>0.0</td>
<td>8</td>
<td>96</td>
</tr>
</tbody>
</table>

- n = No. of cattle in each group
<table>
<thead>
<tr>
<th>Group</th>
<th>Vaccination</th>
<th>% infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Single (n=5)</td>
<td>84</td>
</tr>
<tr>
<td>2</td>
<td>Multiple (n=5)</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>None (controls) (n=5)</td>
<td>96</td>
</tr>
</tbody>
</table>

n = No. of cattle in each group

Fig. 1. Kidney of a nonvaccinated control steer (#001) 4 weeks after inoculation with *L. hardjo* showing thickening of Bowman's capsule, glomerular atrophy, mononuclear cell infiltration in the interstitial stroma and tubular hyaline cast. H & E 400 X
REFERENCES


REPORT ON THE COMMITTEE ON LEPTOSPIROSIS

Chairman: H. G. Stoenner, Hamilton, MT
Co-Chairman: J. W. Glosser, Helena, MT


The committee solicited information about leptospirosis from diagnostic laboratories throughout the United States. As based on information from twenty-six respondents, the prevalence of leptospirosis due to five major serovars (serotypes)—pomona, canicola, icterohemorrhagiae, grippotyphosa, and hardjo—was similar to that found in 1975, with the following exceptions; 1) the prevalence of hardjo in cattle increased in Oregon, New York, Mississippi, and Tennessee, 2) the prevalence of grippotyphosa in swine and cattle in Missouri increased dramatically and the first outbreak due to this serovar was recorded in Massachusetts, and 3) in Minnesota, the seropositive rate for icterohemorrhagiae was 5 to 10-fold higher than in 1975 among swine, horses, and dogs. In about one-third of the states, the hardjo serovar was considered to be a common cause of infertility in cattle. It was estimated by respondents in eleven states that about 20% of abortion in cattle and swine was due to leptospirosis. Few laboratories have made attempts to isolate leptospires from livestock to determine whether serovars other than the five listed before are involved.

The committee received reports about the problems the livestock industry has experienced in the export of bull semen. Criteria for certifying semen as free of leptospires vary tremendously among countries; some require bulls to be seronegative (below 1:400) against the pomona serovar whereas others require a seronegative status against numerous serovars. Considering the variations in requirements, the committee did not believe it feasible to recommend standard criteria that could be applicable to the general export of bull semen. However, in response to requests from the cattle industry, the committee has drafted guidelines for the prevention and control of leptospirosis in bull studs, which would apply to the sale and distribution of bovine semen in the United States. These guidelines are appended to this report.

The committee is seriously concerned about the lack of a reference laboratory that is readily available to governmental and industrial scientists that deal with leptospirosis as an economic problem of livestock. Since the Department of Defense disbanded its reference laboratory several years ago, the sole remaining reference laboratory in this country is supported by the Center for Disease Control in Atlanta, GA. The immediate and urgent need for resolving this problem
LEPTOSPIROSIS

has prompted this committee to submit a resolution for action to the Resolutions Committee.

The committee reviewed the problem relating to the use of bacterins for controlling leptospirosis caused by serovars hardjo and mini-szwajizak. An accompanying report indicates that the commercially available hardjo bacterin may not offer protection against infections due to mini-szwajizak. Moreover, the committee re-emphasized the need to attempt isolation of these serovars to establish their prevalence throughout the United States. This concern is based on the fact that both hardjo and mini-szwajizak have been isolated from clinically affected herds in the U.S., and have been definitely serotyped by internationally recognized reference laboratories.

Further investigations on leptospirosis in horses are needed to identify the leptospires responsible for the high incidence of antibodies to canicola, icterohemorrhagiae, and autumnalis in some parts of the country. With an increase in the horse population, the incidence of seropositive horses is increasing. Current leptospiral bacterins are not licensed by the U.S.D.A. Veterinary Biologics Division for use in that species since the necessary research to determine efficacy and safety has not been conducted. The committee joins the U.S.A.H.A. Committee on Biologics in requesting that U.S.D.A. Veterinary Biologics Division give consideration to the licensure of the presently available bacterins for use in horses.

The Agriculture Information Bulletin No. 394 "Leptospirosis of Domestic Animals," which was prepared by the committee on Leptospirosis, is now on sale at the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402.

Guidelines for the Prevention and Control of Leptospirosis in Bull Studs

PREFACE

These guidelines are based on current knowledge about the immunology, serology, epidemiology, and chemotherapy of leptospirosis.

The microscopic agglutination (MA) test and plate test (PT) currently used for the serodiagnosis of leptospirosis are generally considered to be reasonably reliable. However, results obtained with the MA test in different laboratories vary considerably because 1) uniform methods are not followed, 2) concentration of leptospires, age of culture, and strain of serovar affect sensitivity of antigens, and 3) variable criteria are used for assessing the extent of agglutination. The antigens used in the PT are standardized, but variations in methodology and reading the test are responsible for some divergent results obtained in individual laboratories.

Strongly positive serums and completely negative serums are readily identified in most laboratories. However, the classification of
animals with low levels of antibodies as potentially infected or free of disease varies considerably among different laboratories. Results obtained with these serums depend on the relative sensitivity and specificity of the particular method employed; one laboratory may detect antibodies in the 1:100 dilution of serum (lowest significant titer considered positive) and another may not detect any antibodies at this dilution. The picture is further complicated by the evidence that exposure to nonpathogenic leptospires, such as Illinois 3055, may be responsible for cross-reacting antibodies to pathogenic serovars. Most infected animals develop a significant level of antibodies, but it is known that some do not. Consequently, individual bulls cannot be certified to be free of leptospirosis without knowledge of the serologic status of the herd of origin.

The management and salvage of valuable bulls that are seropositive deserves special consideration. Conceivably, these animals could be rendered free of leptospires by chemotherapy or by isolating animals until shedding ceases naturally. As based on attempts to isolate leptospires from urine of cattle, it has been found that most cattle cease shedding by 3 months postinfection, and it is not thought that any shed more than 6 months. However, no definitive studies have been conducted on this question. A single treatment of steers with 25mg dihydrostreptomycin/kilo body weight was found to eliminate leptospires from their urine, but sufficient experimental trials to insure 100% efficacy of treatment have not been conducted. Furthermore, it would appear necessary to evaluate treatment by repeated attempts to isolate leptospires over extended periods before freedom of leptospires could be established.

I. Facilities and general husbandry.

Paddocks, barns, and pastures should be protected against surface drainage from surrounding area by proper differential in elevation. Where such differential does not exist, a perimeter drainage ditch should be dug to receive surface waters and drain them away from the premises. Water for drinking and/or cleaning purposes should originate from wells appropriately constructed to preclude contamination with surface waters. Besides paddocks for individual bulls, the facility should have at least one isolation facility so separated from the main holding pens that cross contamination with surface water or urine of bulls is precluded. No dogs or other domestic mammals, except cats, should be permitted on the premises. Rodents and wildlife should be controlled; both water and feed supplies should be protected.

II. Stud additions.

A. Serologically negative herds.

Bulls added to the stud should originate only from herds determined to be free of leptospirosis, as based on test of at least 25
animals or 10% of the herd, whichever is greater. None of the serums from animals tested shall react at 1:100 serum dilution on the MA test against *pomona*, *hardjo*, *grippotyphosa*, *canicola*, or *icterohemorrhagiae* serovars. When serums are tested by plate test, none of the serums shall react at 1:40 dilution against *pomona*, *grippotyphosa*, *canicola*, and *icterohemorrhagiae* serovars or at 1:10 dilution against the *hardjo* serovar. The serum from the bull shall be similarly free of agglutinins to these serovars before entry on the premises and again after 30 days of isolation.

B. Serologically undefined herds.

Bulls that originate from herds whose serologic status cannot be defined or herds with animals that have antibodies detectable at not greater than 1:100 dilution on the MA test or 1:40 dilution on the plate test shall be considered to be infected. These bulls should be placed in isolation and treated 3 times with 25 mg/kilo of dihydrostreptomycin at each treatment, scheduled at 3 to 6 day intervals. Efficacy of treatment shall be confirmed by 3 attempts to isolate leptospires in weanling hamsters from urine taken at weekly intervals, beginning 90 days after the last day of treatment. For each test, 4 weanling hamsters shall be treated, as follows: each of 2 shall be inoculated intraperitoneally with 1 ml of freshly voided urine and 2 with a 1:100 dilution of urine in bovine albumen polysorbate medium. Twenty-one days after inoculation, hamsters shall be seronegative and their kidneys free of leptospires, as determined by culture in semisolid bovine albumin polysorbate medium. Bulls that retain leptospires shall be removed from the stud.

C. All teaser animals must meet the same requirements as outlined for bulls.

III. Serologic surveillance.

All bovines, (bulls and teaser animals) in a stud shall be tested for leptospiral antibodies at 6-month intervals. Any bull found to react at minimum positive titers defined in section II shall be considered infected, moved to isolation facilities, and treated with dihydrostreptomycin and evaluated for freedom of leptospires as outlined in section II. If found to be free of leptospires, the bull may be returned to service. Bulls found to react at titers higher than that defined as “minimum positive” shall be removed from the stud. Teaser animals that become sero-positive at any level shall be removed promptly.

IV. Vaccination.

Stud replacements and teaser animals should be immunized with vaccines against the 5 serovars listed in section II at the close of the quarantine period. All other animals should be vaccinated semiannually on the same day blood samples are taken for serologic surveillance.
ABSTRACT

Electronic identification of animals is being developed in Europe and the United States along two lines. Individual animal identification for herd management is being developed primarily for dairy herds of less than one thousand animals. The motivation for this developmental work is to provide more efficient production and records' management within the dairy operation. The other line of development is for tracing the movement of animals through commerce, so that effective disease-control measures can be initiated quickly. Both types of systems have reached the stage where they must be seriously considered as possible systems for widespread use. It is time for uniform standards to be developed for both types of systems, and preparations for incorporating electronic identification into existing regulatory practices at both state and federal levels.

INTRODUCTION

For many years, identification of animals was required primarily as a means of establishing ownership. However, animal production has become much more complicated with state and federal disease programs, frequent movement of animals across state lines, and a significant economic pressure for higher productivity. The need for individual animal identification has become more acute. A wide variety of identification systems have been developed, but essentially all of these systems required reading of the number by the herdsman. This was intrinsically error-prone and not suitable for automation. It has been a serious weak link in dairy herd management, but it has also been a problem for beef herds. Electronic identification offers the potential for automated identification of individual animals, which can be coupled with automated feeding, weighing, and measurement of milk production. This will make it possible to optimize production of individual animals rather than treating them as members of groups.

In Europe, dairy herds strongly dominate the cattle industry, and movement in and out of herds is fairly infrequent. Since labor costs are high, automation has been applied increasingly to the dairy industry, with the result that the cow-to-man ratio has changed from 8 to 40 cows per man in the last 20 years.1 It was natural,

*This paper is a review of work being done in various parts of the world. The work at the Los Alamos Scientific Laboratory was supported by the United States Department of Agriculture and the Energy Research and Development Administration under USDA/ERDA interagency agreement.
therefore, for electronic identification to be developed primarily for increasing the efficiency of herd management in dairies. Individual identification of up to one thousand animals within a herd was a practical goal, and the developmental work was directed primarily toward this objective.

In the United States, there is considerably more movement of cattle, and beef herds comprise a large fraction of the cattle. The United States Department of Agriculture (USDA) has been primarily interested in supporting electronic identification because of its possible use in disease control. Because of the large interstate movement of cattle in the United States, it was necessary to provide for a much larger number than 1,000 specific identification numbers. For example, a national herd identification system requires nearly one billion separate identification numbers. The exact number of separate identities depends upon the coding scheme used.

The funding for developing electronic identification is being provided from two different motivations: (1) herd management, and (2) disease control. However, there are many other livestock interests that should be considered if the system is to gain wide acceptance and use. From these considerations, it became apparent that if the number of unique identification possibilities included not only the herd number, but an individual cow number within the herd, it would be possible to satisfy the needs of regulatory agencies, individual herd owners, feedlot operators, and market operators. For this reason, numerous groups within the United States have supported a 15-digit identification scheme, which would allow for the unique identification of every large livestock animal in the world.

A meeting in Wageningen, The Netherlands, was held in April, 1976, in which all those known to be active in the electronic identification field were invited. A total of about 80 people attended the meeting, which was entitled, “Symposium on Cow Identification Systems and their Applications.” Three groups from the United States were represented; Mr. Hoyle Puckett, from the Agriculture Research Service (ARS), Urbana, IL; Dr. John Hanton, of Montana State University; and I. Because of competitive business reasons, most companies working on the development of electronic identification systems do not publicize their work until it is marketable. Therefore, there may be many systems of which I am not aware. I will report here on what I learned in Europe, and some subsequent information that I have obtained.

EXTERNAL ELECTRONIC IDENTIFIERS

The simplest system described at Wageningen was developed in Germany. Each animal had a halter with magnets located in any of
three possible positions. Presence or absence of magnets on the halter would allow the cow to have access to only one of four different feed compositions, without dividing the animals into production groups.

The other external systems described could identify a few hundred individual animals. An English system enabled the encoding of up to 190 animals by use of a passive transmitter on the neck of the cow. The animal must pass through a coil to energize the transponder. The particular system is not easily expanded to more animals.

Two systems similar to each other were developed in Holland and described at the meeting. They were demonstrated at experimental farms for feeding concentrations in milking parlors and in loosehouse barns. The systems allow for the identification of 254 individual animals with similar transponders, but they have different hardware and computer programs for each. The designers of the transponders reported that they could accommodate a much larger number of separate identification numbers without major changes.

Figure 1 shows one cow in a loose-house, automatic feeding station and another cow waiting to get in. The protein concentrate feeding unit is operated by the transponder on a neck collar, which is energized as the cow reaches the feeding position. If the computer indicates that the cow is entitled to additional feed, a unit of 400 grams is dispensed. Generally, this is consumed in less than a minute. If the cow is entitled to more feed, and it remains in the feeding position for more than a minute, a second portion of 400 grams is administered. This continues until the cow leaves or has used up its allotment of concentrates. The central unit is reset twice a day, and the results are read out to the herdsman along with production information after each milking. Every one or two weeks, the performance of each cow is evaluated and adjustments are made, if required, in the amount of ration for each cow. This system is presently being marketed.

In the milking parlor application of this system, electronic identification is used as one part of a production-monitoring computer system. With this, cows are automatically fed concentrates in the parlor; production data is recorded and results printed out for the herdsman. Figure 2 shows the control booth for this system.

An “electronic key” system has been developed in Scotland for use with feed barriers. This system allows for group or individual animal feeding in a loose-house environment. Control is maintained by different sized barriers and up to 40 different identification numbers. The “key” activates the barrier release, which gives the ani-
mal access to its own feeding station or to a particular feed composition. This system is being marketed.

A system developed by Puckett is being produced at Alfa-Laval for possible commercial sales. This unit has a programmable transponder on a neck chain, which is energized when the cow puts its head through a loop on a feeding manger. Thus, a specific cow can obtain a specific programmed amount of ration from a common dispenser. It does not have individual cow identification as such. Figure 3 shows an early production model.

The UNICAR dairy cow management system has been developed at the Dairy Institute in Braunschweig, Germany. In this system, the cows spend essentially all of their production life in a small cart, like the one shown in Fig. 4. All of the intake and outputs are measured and recorded on a computer. The charts have five locations for magnets with which 32 numbers can be encoded. By using coils instead of magnets, this number can be increased to a much larger number. It is generally agreed that this system is only useful for research dairies, but is not cost effective for normal dairies.

INTERNAL ELECTRONIC IDENTIFICATION SYSTEMS

Neck-chain transponders are not well suited to beef cattle because of the much greater likelihood of loss and possible injury from being caught on fences. Beef herds also require much larger selection of specific identification numbers than dairy herds, because of the frequent movement in and out of various beef herds during the animal’s lifetime. These factors prompted the development in the United States of somewhat different electronic identification systems than those developed in Europe.

**Rumen Implant**

The work at Montana State University (MSU) by Hanton has been directed primarily toward taking advantage of the security of a battery-powered transmitter located inside the animal’s digestive track. Implantation is accomplished with a balling gun to make the animal swallow the transmitter. The specific gravity was such that it permanently resides in the reticulum. The particular development was made possible by the availability of long shelf-life batteries, and a way of turning the transmitter “on” in response to a microwave signal from outside the animal. The system described had an amplitude modulated encoding scheme. This method of encoding is currently being modified to a pulse-code modulated scheme, which is less error prone. A field test on a herd of 25 to 50 animals is expected to start in the early spring of 1977. This model will encode approximately 100 separate identification numbers, but the 15 digit code (one million, billion numbers) can be programmed with this system.
Subdermal Implant

The last system described at the meeting was a subdermal implant, which was designed for measuring the animal's subdermal temperature and transmitting up to 15-decimal digits of identification. However, at the time the presentation was made, a temperature-only indicating transponder was the only type that had been tested in animals. Since that time, a 3-digit identification and temperature monitoring transponder system has been demonstrated and will be described at this meeting to the Electronic Identification Committee. Figure 5 shows a portable model of this system.

SPECIFICATIONS OF ELECTRONIC IDENTIFICATION SYSTEMS

The International Brand Conference has suggested a 15-digit system for regulatory functions. Work done at our Laboratory indicates that such a system is feasible, but further developments and field testing will be required before it has been demonstrated as practical. There has been some indication that the basic concepts of the Los Alamos Scientific Laboratory (LASL) system will be incorporated into commercially manufactured units. However, the dairy industry could be served quite well with an electronic identification system having less than 15 digits of identification. Since the dairy industry is the one most likely to incorporate electronic identification into its practices first, it is important that impetus be given to the potential manufacturers and livestock industry to incorporate an identification system, which will be amenable to the beef industry and disease control. The various groups represented here can and should offer suggestions for inducing the manufacturers to produce, and the various user groups to incorporate a system suitable for disease control. Perhaps, regulatory agencies can see fit to partially subsidize the use of acceptable identification systems.

CONCLUSIONS

Electronic identification of animals is a reality now with a number of experimental systems and a few commercial ones. The time is right to coordinate the requirements of various livestock industry segments and promote compatible developments. There are other industries with interest in electronic identification. It has been reported that the tanning industry has a strong interest in reducing and perhaps eliminating the use of hot-iron brands as a means of identification, since it causes considerable damage to the hide and subsequent wastage. A focal point is needed to bring these various factions together and arbitrate their needs. An active ad hoc group needs to be organized to perform this function at least on a temporary basis. This meeting can serve as the initiating force.
Figure 1. Automatic feeding in a loose-house environment at an experimental farm in Holland. One cow is eating its protein concentrate allotment while another is waiting for its turn. A neck-strap transponder can be seen on one cow.

Figure 2. The milking parlor instrument booth at an experimental farm in Holland. The individual animal identification numbers are displayed to the milker who is in a pit below the booth. The 32-unit control panel for setting the precise protein concentrate ration for each animal can be seen behind the man.
Figure 3. An early Alfa-Laval production model of the Puckett individual animal feeding system. The energizing coil to power the transponder is permanently mounted around the entrance hole.
Figure 4. A cow in one of the UNICAR carts. The metered food is supplied and wastes removed and weighed for each cow at each milking. This system is probably only useful for research.

Figure 5. The LASL 1976 model electronic identification and temperature monitoring system. The portable design was built to demonstrate its possible use on the range.
REFERENCES


6. DACA Electronic Engineering & Contracting, P. O. Box 4 Lelystad, Holland.

7. CALAN, Calan Electronics Ltd., Crossroads, by Ormiston East Lothian, Scotland, Great Britain.


12. Identronix Corp., 300 Harvey West Blvd., Santa Cruz, CA 95060.

THE USE OF ELECTRONIC IDENTIFICATION IN THE
DHIA PROGRAM
Bliss H. Crandall*

INTRODUCTION

The National Dairy Herd Improvement Program is a cooperative
dairy record keeping system which provides a member dairyman
with an electronic management information system for detailed man-
agement and evaluation of cows in his herd. This effective program
has been developed over a period of seventy years.

Dairy cows must be managed as individuals. Each cow must be
identified, and significant events pertaining to that cow must be
recorded by the dairyman as they occur on a daily basis. At about
30-day intervals, a supervisor hired by a local Dairy Herd Improve-
ment Association weighs, samples, and evaluates the milk produced
by each cow. These data, together with a record of events supplied
by the dairyman, are reported to a computing center on a prelisted
barn sheet.

The computing centers provide dairymen and all cooperating
agencies with authorized information from the dynamic data base
on a timely basis to meet the objectives of the national program.

The identification of individual cows and collection of basic data
is a costly, tedious, time consuming process subject to human error.
The data collection process could be aided greatly by modern elec-
tronic technology, to identify individual cows, detect physiological
changes associated with heat periods and pregnancy and to capture
all events and data including milk weights in machine-readable form
for direct entry to computers.

Dairy Cows Managed As Individuals

Each cow in a dairy herd must be managed as an individual to
provide for efficient production. Herds producing fluid milk for a
Grade A market should maintain a fairly constant flow of milk
from day to day. This requires an operation with replacement heifers
in all stages of growth, cows constantly being culled, and cows in all
stages of lactation with a uniform number calving throughout the
year. The result is a complex population with each cow requiring
attention almost on a daily basis. The action required depends upon
each cow's stage of lactation, level of production, stage of reproduc-
tion, past history, and probable future capability. This makes the
data on individual cows ideal for tabulation and analysis by com-
puters to aid in the daily decision-making process.

Lactation Curve

When a cow calves she begins producing milk at about ten per-
cent below her peak production, which is usually reached 60 to 90
days later. Her production then drops at about ten percent per month

*Owner and General Manager, DHI Computing Service, Provo, Utah 84601.
CRANDALL

until she is turned dry, generally about 60 days before her next calving.

Most dairymen try to manage their cows to have a calf every twelve months. This goal is not often reached. The average is generally about 400 days or $13\frac{1}{3}$ months. A typical lactation cycle and curve for milk production is shown in Figure 1.

![Figure 1. Typical Dairy Cow Lactation Cycle.](image-url)

The lactation curve may be divided into two major parts depending upon whether the cow is open or pregnant. A cow is open during the first part of the lactation from calving to the date of conception. She is pregnant from conception until next calving. The pregnancy may be terminated by abortion.

The open period may be divided into two parts—a waiting period and a breeding period, while the pregnancy period covers “milking while pregnant” and the ‘rest or dry period.” (See Figure 1.)

These four periods are discussed below.

**Waiting Period.**

Soon after calving each cow is usually examined by a veterinarian and treated if necessary to bring the reproductive organs back to a normal, healthy condition. The diagnosis of abnormalities and treatment given should become a part of the cow's permanent record.

One of the most critical problems in dairying is the failure to detect cows in heat. Various methods are used. None is foolproof. It would be great if someone would develop an electronic method of surveillance to monitor the physiology or activity of each cow and signal those that are in heat.

Each date when the cow is observed in heat should be recorded. If the cow is normal, heat dates, once started after calving will occur at about 21-day intervals. Most dairymen will wait for the first heat date after 45 to 60 days in milk before beginning to breed the cow. Heat dates normally stop when conception takes place.
Breeding Period.

Most cows in large, well-managed herds are bred artificially using frozen semen at the first heat period after about 60 days in milk. The frozen semen may be stored indefinitely at the farm in a liquid nitrogen tank, where it is available for daily use. This technique makes planned matings possible to maximize genetic improvements. In some herds these planned matings are actually made by computer.

Cows do not always conceive when they are bred. On the average, it takes about two breedings for each conception. Services per conception is an important measure of reproductive efficiency and should be known to each dairyman at all times.

It is important that every time a cow is bred the date and bull used be recorded as a part of the cow’s permanent record. Cows are generally examined by a veterinarian from 30 to 90 days after last breeding to determine whether the cow is open or pregnant. An electronic check for pregnancy would be of great value. Cows that remain open become candidates for culling when their production reaches the break-even point.

Milking While Pregnant Period.

Cows require about 280 days from conception to calving, and since most dairymen believe that a cow should have a rest period of about 60 days, each cow will milk about 220 days after conception before turned dry.

Attention is required during this period of the lactation to watch for abortions, to breed cows that come back in heat, to cull low producers, and to dry each cow at the proper time to provide the desired rest period before next calving.

Rest or Dry Period.

Cows that are not being milked should be prepared for calving a short time before they are due. The dairyman should be alerted to the due date for each cow and those that do not calve as scheduled should be observed to make sure they are still pregnant.

The birth date, sex, breed, and identification of each calf born when the cow freshens should be made a part of the cow’s permanent record. The cow is transferred to the milking herd and the next lactation cycle begins. The calving interval is the elapsed time from one calving to the next and is important for each dairyman to know.

Identification for Within Herd Management.

In order to meet the problems existing in the above-mentioned areas, successful dairying requires that the identity of individual cows within a herd be known at all times. When a significant event occurs it must be recorded and associated with the individual cow.
Even with today's large herds a four digit number is sufficient to insure that no two cows will have the same number. When a cow leaves the herd, her number may be reassigned. It would seem that even with electronic identification a visible system of neck chains or plastic ear tags would be necessary for daily management of individual cows.

A four digit electronic I.D. number would be very advantageous in the DHIA system if both the event and cow I.D. could be automatically recorded in machine readable form. This would seem possible for milk weights, although weighing and sampling devices would have to be approved for use in the official program.

Failure to detect cows in heat is a very costly mistake often made in managing dairy herds today. An electronic monitoring system to detect cows in heat by measuring variation in physical activity and/or temperature along with each cow's four digit I.D. number would have great value. These data could be captured in an on-site mini-computer or on a cassette to be transmitted daily to a remote computer.

Another important management activity is determining whether or not a cow is pregnant. This would be more difficult to determine electronically. There must be changes in the physiology of a cow after conception takes place, and if these changes could be detected and recorded along with the cows four digit I.D. number in machine readable form it would be most helpful.

**On-Line Daily Management System.**

The DHI Computing Service at Provo, Utah is now offering a realtime daily dairy management information system. Terminals are made available at the participating dairy to read and update the dynamic data base across phone line to the Central Computer in Provo, Utah.

There are currently eleven functions available, as shown below. Any one of these eleven functions becomes operational when the code number is requested at the terminal keyboard. Data may be displayed on a CRT and/or printed as a hard copy.

<table>
<thead>
<tr>
<th>DAILY DAIRY MANAGEMENT FUNCTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. LIST COWS TO CHECK FOR HEAT</td>
</tr>
<tr>
<td>2. ENTER COWS FOUND IN HEAT</td>
</tr>
<tr>
<td>3. ENTER COWS BREED</td>
</tr>
<tr>
<td>4. LIST COWS TO BE CHECKED BY VETERINARIAN</td>
</tr>
<tr>
<td>5. ENTER RESULTS OF VETERINARIAN CHECK</td>
</tr>
<tr>
<td>6. LIST COWS TO BE TURNED DRY</td>
</tr>
<tr>
<td>7. ENTER COWS TURNED DRY</td>
</tr>
<tr>
<td>8. LIST COWS DUE TO CALVE</td>
</tr>
<tr>
<td>9. ENTER COWS CALVED</td>
</tr>
<tr>
<td>10. LIST POTENTIAL CULLS</td>
</tr>
<tr>
<td>11. ENTER COWS LEAVING HERD</td>
</tr>
<tr>
<td>ENTER DESIRED FUNCTION CODE</td>
</tr>
</tbody>
</table>
Functions 1, 4, 6, 8, and 10 list cows requiring action or review by the herdsman. Only those cows meeting conditions specified by the dairyman are listed.

Functions 2, 3, 5, 7, 9, and 11 are input formats which are used to enter events or action taken by the herdsman. The record of these events immediately updates the data base for the herd. Sample frames of functions one through eleven are shown on the following four pages.

1. **COWS TO CHECK FOR HEAT**

   **05-27-76**

<table>
<thead>
<tr>
<th>COW NO.</th>
<th>SPRING L</th>
<th>PRODUCTION</th>
<th>LAST BRED OR HEAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P T</td>
<td>DIM MILK RV</td>
<td>DATE NO SIRE TECH</td>
</tr>
<tr>
<td>3449</td>
<td>3 4</td>
<td>57 93.5</td>
<td>98 5-07 HEAT</td>
</tr>
<tr>
<td>3452</td>
<td>3 4</td>
<td>31 94.8</td>
<td>119</td>
</tr>
<tr>
<td>3493</td>
<td>2 4</td>
<td>84 88.5</td>
<td>103</td>
</tr>
<tr>
<td>3495</td>
<td>1 4</td>
<td>36 80.0</td>
<td>83 5-06 HEAT</td>
</tr>
<tr>
<td>3554</td>
<td>1 3</td>
<td>36 88.5</td>
<td>107</td>
</tr>
<tr>
<td>3569</td>
<td>2 3</td>
<td>57 66.3</td>
<td>75</td>
</tr>
<tr>
<td>3578</td>
<td>1 2</td>
<td>37 91.3</td>
<td>97</td>
</tr>
<tr>
<td>3580</td>
<td>3 3</td>
<td>44 69.0</td>
<td>71</td>
</tr>
<tr>
<td>3588</td>
<td>1 3</td>
<td>114 85.5</td>
<td>111 5-06 1 9H107 H</td>
</tr>
</tbody>
</table>

   CONTINUED

2. **COWS FOUND IN HEAT**

   **05-27-76**

<table>
<thead>
<tr>
<th>COW NO.</th>
<th>DATE IF</th>
<th>NOT TODAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 3449</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. 3495</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. 3588</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   When cows in heat 'today' are added to the master file, the characteristics of these cows are displayed on the terminal as shown in Frame 2a below. This assists the herdsman in deciding which cows to breed and the service sire to use for each.

2a. **COWS FOUND IN HEAT**

   **05-27-76**

   | Cow No. | String L | Production | Planned S. Sire | Last Bred Or Heat | Sire Of | Min |
   |---------|----------|------------|-----------------|-----------------|---------|
   |         | P T      | Dim Milk RV | 1st 2nd | Date No Sire Tech | Cow BR-DI |
   | 3449    | 3 4      | 57 93.5     | 98 15H120 9H107 | 5-27 HEAT SIR | 6-10 |
   | 3495    | 1 4      | 36 80.0     | 83 3145 9H107 | 5-27 HEAT 11H151 | 7-01 |
   | 3588    | 1 3      | 114 85.5    | 111 9H107 15H120 | 5-27 1 HEAT TRANS | 4-14 |

END OF LIST
3. **COWS BRED**

05-27-76

| COW * SERVICE * CULL OR * DATE IF * |
|---|---|---|---|
| NO. * SIRE USED TECH * ONE * NOT TODAY * |
| 1. 3588 9H107 H |
| 2. |
| 3. |
| 4. |
| 5. |
| 6. |
| 7. |
| 8. |
| 9. |

---

4. **COWS TO CHECK BY VETERINARIAN**

05-27-76

| Cow * String * L * Production * Last Breeding * Last P CT* |
|---|---|---|---|---|
| No. * P T * No * Dim Milk RV * Date No. Dys Sire Tech * Date P-O* |
| 2657 3 7 88 90.8 103 5-09 18 HEAT |
| 2688 1 8 43 116.5 122 |
| 2704 1 7 372 23.5 95 3-05 3 83 11H161 |
| 2799 3 7 194 79.8 115 4-09 2 48 11H103 5-24 O |
| 2874 2 6 147 77.5 87 4-14 1 43 28H198 5-25 O |
| 2895 2 6 179 67.0 83 5-26 1 1 |
| 2919 1 6 262 49.8 101 4-18 4 39 REX 5-24 P |
| 2932 2 7 61 82.6 84 |
| 2966 3 6 120 114.5 113 4-14 1 43 7H477 |
| CONTINUED |

---

5. **COWS CHECKED BY VETERINARIAN**

05-27-76

| COW * OK TO * PREG OR * DATE IF * |
|---|---|---|---|
| NO. * BREED * OPEN * NOT TODAY * |
| 1. 2688 B |
| 2. 2704 P |
| 3. 2932 B |
| 4. |
| 5. |
| 6. |
| 7. |
| 8. |
| 9. |
### 6. COWS TO BE TURNED DRY

**05-27-76**

<table>
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<tr>
<th>Cow No.</th>
<th>P</th>
<th>T</th>
<th>Date</th>
<th>Milk</th>
<th>Fat</th>
<th>Val</th>
<th>Dim</th>
<th>Edd</th>
<th>Date Dim</th>
<th>Edd</th>
</tr>
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<tbody>
<tr>
<td>2653 3</td>
<td>6</td>
<td>7-14</td>
<td>35.8</td>
<td>1</td>
<td>18030</td>
<td>601</td>
<td>88</td>
<td>373</td>
<td>48</td>
<td>3-21</td>
</tr>
<tr>
<td>3263 2</td>
<td>4</td>
<td>7-21</td>
<td>10.5</td>
<td>T</td>
<td>23630</td>
<td>771</td>
<td>114</td>
<td>339</td>
<td>55</td>
<td>4-24</td>
</tr>
<tr>
<td>3372 2</td>
<td>3</td>
<td>7-31</td>
<td>15.0</td>
<td>N</td>
<td>18450</td>
<td>584</td>
<td>89</td>
<td>355</td>
<td>65</td>
<td>4-08</td>
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<tr>
<td>3391 3</td>
<td>3</td>
<td>7-15</td>
<td>23.3</td>
<td>1</td>
<td>17260</td>
<td>632</td>
<td>92</td>
<td>327</td>
<td>49</td>
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<td>8-03</td>
<td>20.0</td>
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<td>501</td>
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<td>68</td>
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<td>N</td>
<td>19660</td>
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<td>112</td>
<td>438</td>
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<tr>
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<td>7-23</td>
<td>27.8</td>
<td>T</td>
<td>17250</td>
<td>654</td>
<td>98</td>
<td>360</td>
<td>57</td>
<td>4-03</td>
</tr>
<tr>
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<td>1</td>
<td>21330</td>
<td>777</td>
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<td>325</td>
<td>51</td>
<td>5-08</td>
</tr>
</tbody>
</table>

**CONTINUED**

### 7. COWS TURNED DRY

**05-27-76**

<table>
<thead>
<tr>
<th>Cow No.</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>3391</td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>3728</td>
<td></td>
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<tr>
<td>6.</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td></td>
</tr>
</tbody>
</table>

### 8. COWS DUE TO CALVE

**05-27-76**

<table>
<thead>
<tr>
<th>Cow No.</th>
<th>String</th>
<th>L</th>
<th>Last</th>
<th>Last</th>
<th>Date</th>
<th>Est</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
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<td>9</td>
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<td>STRLITE</td>
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<tr>
<td>2582</td>
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<td>6</td>
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<td>31.5</td>
<td>RUFUS</td>
<td>5-29</td>
<td>91</td>
</tr>
<tr>
<td>3272</td>
<td>1</td>
<td>4</td>
<td>N</td>
<td>29.8</td>
<td>JET</td>
<td>6-10</td>
<td>211</td>
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<tr>
<td>3414</td>
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<td>3</td>
<td>1</td>
<td>18.3</td>
<td>A ROCKE</td>
<td>6-04</td>
<td>69</td>
</tr>
<tr>
<td>3539</td>
<td>2</td>
<td>2</td>
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<td>38.5</td>
<td>PONCHO</td>
<td>5-11</td>
<td>105</td>
</tr>
<tr>
<td>3595</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>17.5</td>
<td>PONCHO</td>
<td>5-24</td>
<td>86</td>
</tr>
<tr>
<td>3687</td>
<td>1</td>
<td>2</td>
<td>N</td>
<td>45.5</td>
<td>A ROCKE</td>
<td>6-10</td>
<td>59</td>
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<td>3707</td>
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<td>2</td>
<td>N</td>
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<td>5-31</td>
<td>50</td>
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<tr>
<td>3828</td>
<td>3</td>
<td>1</td>
<td>N</td>
<td>53.3</td>
<td>RUFUS</td>
<td>6-11</td>
<td>61</td>
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</table>

**CONTINUED**
9. COWS CALVED
05-27-76

<table>
<thead>
<tr>
<th>COW * IDENT</th>
<th>DESCRIPTION OF CALF</th>
<th>* DATE IF</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO.</td>
<td>SEX SIRE TECH DIFF</td>
<td>SIZE COND</td>
</tr>
<tr>
<td>1. 3539</td>
<td>2085 M PONCHO</td>
<td>H 2 90 1 1</td>
</tr>
<tr>
<td>2. 3595</td>
<td>4674 F PONCHO</td>
<td>H 2 120 1 1</td>
</tr>
</tbody>
</table>

10. POTENTIAL CULLS
05-27-76

<table>
<thead>
<tr>
<th>Cow <em>String</em></th>
<th>L * Production</th>
<th>* Days * Last Breeding</th>
<th>* Date</th>
<th>Lin e</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>P T</td>
<td>No</td>
<td>Dum</td>
<td>Milk Cnt</td>
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<tr>
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<td>DRY</td>
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<td>3</td>
<td>330</td>
<td>14.0</td>
</tr>
<tr>
<td>3485</td>
<td>1</td>
<td>3</td>
<td>DRY</td>
<td>23.5</td>
</tr>
</tbody>
</table>

CONTINUED

11. COWS LEAVING THE HERD

<p>| NO. | 7, 8, 9 | 3, 4, 5, or 7 NOT TODAY |</p>
<table>
<thead>
<tr>
<th>COW</th>
<th>CODE</th>
<th>REASON</th>
<th>DATE IF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>3462</td>
<td>8</td>
<td>4</td>
</tr>
</tbody>
</table>
If events and cow numbers were recorded electronically on a cassette the data base could be updated by transmitting data from the cassette to the computer on a daily basis to enhance the functions of the on-line system.

Individual cow pages are now being modified to include the complete health record of each cow. These data will be added to the data base and will therefore be available for display and summary in the on-line system.

*Individual Numbers for The National Data Base.*

In order for the dynamic data base system accumulated on-line at the computing center to interface with the National Data Base, the four digit control number used for quick and frequent identification of cows within herds, is cross referenced to a nine position permanent number. This number becomes a part of every record which is added to national files. The breed of each animal always accompanies the number.

The number performs several important functions in the DHI program. The first two high order positions identify the registry, recording agency, or state where the number is assigned. Alphabetic characters in any or all positions 3, 4, and 5 indicate a grade animal whereas the absence of letters in these positions indicates a registered animal. These functions of the present I.D. number are widely used in all National Cooperative Dairy Herd Improvement Programs and computer systems. Any national livestock electronic numbering system should carefully consider these functions of the present system.

The National Dairy Record program is a model of cooperation among all phases of the industry. It has provided great benefits to both producers and consumers of dairy products. Certainly, when we can keep track of every heart beat of our astronauts on the moon . . . we can use the same technology to do a better job of managing individual cows in the dairy herds of the world. Electronic identification has some problems but by working together in this area, mankind is ready to take another giant step forward.
INTRODUCTION

While being affiliated with a breed registry organization for 27 years, identification of animals has meaning to me that may vary from that of many others but I hope we can agree that identification should be more than identification simply for the sake of putting a number on an animal. My concerns have not only involved the identification of the individual animal as one among the masses in the national dairy herd, or one of those for which a certificate of registration has been issued for more precise identification with correct sire, and dam and birth date, but down to the extreme of demanding verification of identification or correction in identification involving inspection of records, examination of ear tags, and the use of blood typing. The effort to maintain the accuracy and integrity of a record keeping process that supports that improvement of the genetic level of the national dairy herd is substantial. While a small degree of error in identification in certain phases or parts of genetic evaluation programs may be permissible, there are those phases in the record keeping process whereby error is not permissible.

While we are approaching 100 years of tradition supporting the value and integrity of a registration name and a registration number, with these bearing substantial weight of prestige and value to the owner of the animal with which associated, it is the registration number most adaptable to mechanization, computerization or automation. Be that as it may, this number is not often used in the day-to-day management of the dairy herd.

Each animal in the herd has a barn name, or number. She has an index number if on a production testing program, and thus through computerized processes, there is cross referencing between the registration number, an index number, a barn number or name and, in the case of unregistered animals, the ear tag number takes the place of a registration number, as the unique number for identification.

National Identification System

We have a national identification system. Veterinary Services Memorandum 578.6, dated October 26, 1973, describes a National Identification System and Supplement No. 1 describes the manner in which the code for ear tags are distributed, the manner in which numbers are assigned, and who is responsible for the distribution and

*Special Assistant Holstein Friesian Association of America to Electronic Identification Conference.
the manner in which records of assignment are maintained. Supplementing the uniform ear tagging system is a system of back tagging, a system of tattooing of swine, with prescribed procedures for record keeping.

The National Identification System as brought about through the unique coding of ear tags has been adopted as a universal identification system by the livestock industry. In the dairy industry in particular. With the exception of the 1 million cows identified with registration numbers, the remainder of the 3½ million dairy animals enrolled in production testing programs are identified with the National Identification System now in existence and which has deep roots in computer processing procedures and involving the economic value of each animal with which each number is associated, nearly half of which are integrated into genetic improvement programs so ingrained in the industry that any change is of traumatic significance. There can be cited certain limiting factors affecting the National Identification System now in use in that there is permitted the assigning of ear tag numbers without the tag inserted in the ear of the animal, animals lose the ear tags thus lose their identification unless there is adequate record keeping to maintain continuity with the replacement tag and, in spite of all of this, nearly 60% of the records of production of the animals supposedly identified are not of value for use in the dairy industry's genetic evaluation programs because of the lack of records permitting the identification of the sire.

New Emphasis on Identification

Because of the increasing pressure to decrease this loss of information that is of substantial value, or could be of substantial value to the genetic improvement of the national dairy herd, there are new programs proliferating throughout the industry to capture the identification of an increasing number of these animals. Hopefully these new programs will capture the identification of the entire population in such a way that identification is useful for genetic improvement. It then follows that the record systems accompanying this identification can serve other useful purposes to increase the well-being of the national herd.

Records for Herd Health

Though the assignment for this presentation calls for evaluating electronic identification in connection with dairy herd health records management, and while we could discuss the possibility of detailed applications, there is no experience from which to draw and I want to emphasize that I do not profess to be a specialist in the field of herd health. I try to monitor the national situation for the benefit of our breeders, though even in this, my exposure is limited.
As we go through dairy publications, as we review the results of research and as we review the total research effort, we must be impressed with the attention given the matter of herd health and, in particular, problems relating to reproduction. The public press keeps the problems related thereto before us constantly with the constant admonition for improving health maintenance procedures; for improving the reproductive capacity of our national dairy herd, and individual herds, with the overall admonition that such improvement comes with the improvement in our record keeping systems. Herd health—Reproductive and otherwise, is undoubtedly the weakest part of management procedure.

In support of this, we see example after example of good, complete herd record keeping systems that permit the manager to anticipate the breeding date for a cow, to anticipate the need to start treatment for pneumonia, to anticipate the need to treat for mastitis, or any number of other herd health problems, including the detection of serious contagious diseases. If there is a tendency to misinterpret my use of the word anticipate, in a sense it is intended to mean either anticipate or recognize the symptoms when treatment can be effective. The Sun Belt Dairyman's Article on McArthur Farms entitled "Animal Health by the Numbers" is an example. In this herd, cow information must be so readily available, the time factor does not permit participation in regular DHI production testing—turnaround is too slow for the information to be effective.

**Cumbersome Identification Procedures**

We dwell at length on matters of record keeping but who can read an eartag, a neck chain number or a tattoo in a herringbone parlor? Or, who can read those quickly and effectively, or any other type of milking situation without serious inconvenience. Therefore, lacking personal acquaintance with each cow by the milker and without reference to an attached number, there can be no communication by the milker to identify a cow coming in heat or a cow with a health problem or symptoms thereof whether it relates to mastitis, or anything else. Much valuable information that could originate from the person milking the animal who has the closest personal contact is lost for lack of identification and communication.

**New Procedures are being Developed**

True, we are figuring out and/or working on devices or gimmicks and procedures involving human labor to detect cows in heat and to recognize the symptoms of disease in its early stages. While there are now sophisticated devices appearing on the market that are tending toward the demand for management aids of this era—are we not for all practical purposes entering a new era of dairying demanding new herd management techniques, and record keeping systems. Can
we admit that the identification techniques and record keeping sys-
tems of the past refuse to meet the needs of the present and the en-
croaching future resulting in a herd management gap that must be
closed if we are going to make significant gains on our major manage-
ment problems without impossible inconvenience and undue expense.

**Trends of the Industry**

It would undoubtedly be redundant to repeat the statistical history
of the dairy industry citing the decrease in the number of farms with
dairy cattle, the decrease in the number of dairy cows in the United
States, going from 21 million to 11 million in the past 25 years, with
a projection estimating the number at 9 1/2 million by 1984 on 150,000
farms with the number on each farm nearly double that of today.

We cannot argue with history and the degree to which the prog-
nostication is accurate may be influenced by factors over which we
have no control, some of which are political in nature. Be that as it
may, there is substantial agreement among the prognosticators that
this is an accurate sense of direction and, this being the case, lets
reflect on that which happens as a herd increases or expands.

**Problems with Expansion**

Studies at Michigan State University in 1971 revealed that the
main problems confronting expanded dairy farms were ranked with
animal health in first, labor second, catching cows in heat third, and
manure handling fourth. In this study, the culling rate during the
early years of expansion increased 2.4%, veterinarian usage per cow
increased 13.1% and reproductive problems per cow increased 119%.

Wrapped up on the number 1 problem of animal health cited in
this study is the matter of calf mortality cited from a different study
that said calf mortality increased to nearly 35% as herds increased
to 200 or more.

Maintaining animal health, labor, and catching cows in heat, are
all related in varying degrees depending upon the broadness or scope
of interpretation of each so discussion on one may well relate to the
other, all in varying degrees.

Another Michigan study by Burt Mellenberger and David Harri-
son involving 881 cows in 12 herds led them to the conclusion that
dairymen can save $75 or more per cow if they can develop a dairy
breeding program based on 12 month calving intervals and Dr. John
Kendrick reduced this to a figure of an expense of $1.32 for each day
a cow is open when comparing a 12 month calving interval with a 14
month calving interval. His study gave a $238 advantage to the cow
with a 12 month calving interval.

I recognize it is difficult to take these short quotes out of context
and reflect the full intent accurately, and if there is any inaccurate reflection of the fact, I sincerely apologize. But, add to this the results of the Minnesota study that said that 60% of the cows that leave dairy herds go involuntarily with reproductive problems at the top of the list.

**Trend will Continue**

We've established the fact that we will continue the trend toward larger herds, and the studies reveal that management capacity and procedures for management cannot adjust to the new environment without experiencing substantial loss in efficiency, at least during the first years, though recognizing that the successful survivors will increase the efficiency of their operations. However, the loss period can be reduced or corrected by the development of record keeping systems to which the dairyman can adapt with a minimum of inconvenience which will permit adequate herd health management. This record keeping expense that is becoming increasingly costly is demanded by the consequences for the lack of records.

**Do Dairymen Know?**

Given all that has been written in the public press describing the content of an adequate record keeping system, given all of the educational effort through the United States Agricultural Extension Service on that which is adequate for record keeping systems, through direct contact and through publications, given all of the devices and technology that has been made available to the dairyman to this time and which he can afford, and given the economics of the industry, there is an obvious management gap between that which should be, and that which has actually been translated into active practice in the majority of our herds. This observation must not overlook the well managed herds that stay ahead of their problems with the use of good records. At the same time, these herds are searching for more efficiency and less expense.

**Is Labor a Problem as Such**

If labor ranks second as a major problem in the course of expanding the size of an operation, perhaps this can be directly related to the inability of labor to communicate about an animal because of the lack of a way to identify a cow that appears to show symptoms of heat, mastitis, or anything else.

It is not hard to recognize the increased efficiency and value of a milker who sees the identification of a cow as she enters the milking stall through an electronic unit and can then communicate through any of various number of forms the health status of the animal, suspicions of infection and, yes, even the pounds of milk produced.
Temperature Monitoring

If the temperature monitoring capability is added to electronic identification providing both positive identification and body temperature, the increased effectiveness of communication between the milker and the record keeper, or the calf feeder and the record keeper or herdsman and record keeper can create one of the most dramatic improvements in herd health management in the history of the industry.

Computerization

Add to this the possibility of additional computerization within the herd that could lead to automatic electronic communication to the record keeper which may be a machine. The impact of electronic identification and temperature monitoring would be magnified and add a totally new dimension to the management process.

In the June 10, 1976 issue of Hoard's Dairyman, Dr. L. C. Allenstein of Whitewater, Wisconsin, elaborated at length on the subject of "What an Animal's Temperature can tell you". He reiterated his observation in an interview. Few here will disagree with the observation that the body temperature can signal the beginning of pneumonia in one or more of its various forms from 36 to 24 hours in advance of any visible indication of the symptoms and such lead time on treatment would obviously reduce losses nearly to the point of elimination, with incalculable savings. These types of observations go on at great length covering a broad spectrum of herd health. This is not meant to indicate that the temperature monitoring capability may not require more sophisticated interrogating equipment than that for pure identification.

There are many indications that the age of electronics in the management of dairy herds is here. Given Dr. Austin Oxender's 1971 survey of 477 Michigan dairy herds showing an average calf mortality rate of 34.9% in herds of 200 cows or more, with mortality greatest in herds using antibiotics compared with those not using them, one tends to conclude that treatment was started too late to be effective. Early treatment that would save these calves would support a substantial investment in a system that would effectively reduce this loss. But, the McArthur Farms 1.2% mortality rate would be hard to beat with any system. However, more dairymen should come close with less sophisticated management if they had more sophisticated management aids.

If the temperature monitoring capability increased the ability to detect heat and increased breeding efficiency by 50%, the studies cited would indicate an increase average income per cow from $35 to $60. In the case of cows of exceptional merit, as would be the case
in a registered breeding herd, such improvement would result in increased income through additional calves.

SUMMARY

In summary, it seems appropriate to again recognize that over 30% of the nation's 11 million dairy cows, two years old and over, are attached to one or more computers, all of which cows are identified by the now existing National Numbering System (uniform ear tagging system) with the exception of about 1 million cows that are identified with registration numbers, also considered official for animal health identification. The 3½ million cows in production testing programs come from 53,000 of the 300,000 herds with dairy cows, only 230,000 of which have ten or more cows. To this number of identified animals can be added another 2 million registered animals not on DHIA and about another one million young animals identified in one form or another, leading to an observation that nearly 50% of the national dairy herd is identified with unique numbers.

Though these animals are tied to the computer with registration numbers and ear tag numbers, cross indexed with index numbers which may or may not be herd numbers, the herd owner, the manager, and the cow milker, identify these animals with a herd number separate and apart from the ear tag or the registration number.

However, the registration and the ear tag number assigned to each animal are unique to that animal and permit computerized identification that serves a comprehensive purpose.

Let us recognize the decreasing trend in herds and numbers, with increasing numbers per herd magnifying the management problems, requiring more consulting service. Then, let's recognize the trend toward the increasing number of dairy animals being registered with their record of ownership maintained by organizations in the private sector that can trace the complete ownership record for the benefit of regulatory or research people, with the trend of an increasing number of animals affiliated with the production testing program and thereby identified through a unique numbering system, all involved in one or more computerized operations permitting recall, identification, and location. Then we must recognize the dairy industry's increased emphasis and gathering momentum in positively identifying an ever increasing proportion of its total population in order that it will all contribute to genetic improvement. History supports the observation that the dairy industry identification procedures have contributed to the well-being of animal health regulatory procedures with various types of identification having official recognition. In light of these observations, it is reasonable to conclude that a system of electronic identification will find its place in the dairy industry. Given reasonable latitude, it is in demand at the moment.
A new system will be readily accepted if it can come with a minimum of inconvenience in adjusting from one system to another and with sufficient flexibility that perhaps more than one numbering system can be considered unique and official without missing the goal of a total national identification program to be brought to reality on a voluntary basis.

REFERENCES

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Dairy Herd Management—September 1976—August 1976
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Michigan State University Research Study
Dairy Herd Improvement Letter—June 1976
USDA-APHIS-VS Memorandum 578.6, Sup. I 12-3-74
USDA-People on the Farm: Dairying—May 1976
1976 Dairy Producer Highlights—National Milk Producers Federation
REPORT OF THE COMMITTEE ON
LIVESTOCK IDENTIFICATION

Chairman: S. H. Flora, Brownsville, TX
Co-Chairman: J. Ralph Bishop, Tipton, IN


As a result of participation by committee members at livestock identification programs and meetings during 1976 it is obvious that electronic identification of livestock is commercially available now. To preclude a proliferation of incompatible systems and duplication of individual animal numbers the committee has proposed and forwarded to the appropriate committee a resolution to urge the Secretary of the United States Department of Agriculture to appoint a National Advisory Committee, representative of all concerned, to advise and guide the United States Department of Agriculture in taking those steps necessary to preclude proliferation of incompatible systems and prevent duplication of individual animal numbers. This action to be initiated within six months. This approach to the problems is considered, by the committee on livestock identification, to be essential if the full potential of electronic identification of livestock is to be realized. Failure to develop a single, compatible national system will greatly increase the amount of money spent to use this tool and limit its use to individual herd management. Suggested criteria for an electronic identification system was made a part of the resolution. The suggested criteria would assure a single, compatible system, create a fifteen digit numbering system uniquely identifying individual animals, make voluntary individual livestock owner participation, regulate data collection, storage and interrogation to provide confidentiality and privacy of information, and make it a violation of federal law, if enacted, to remove or tamper with an official electronic identification implant.

A second resolution was proposed and forwarded to the appropriate committee to urge the Secretary of the United States Department of Agriculture to make available to the Los Alamos Scientific Laboratory $100,000 to complete research work, now in progress, on electronic identification of livestock. The Los Alamos Scientific Laboratory has made a firm projection of research completion in late 1977 or early 1978 if the previously mentioned funds are made available for project completion.
The United States Animal Health Association Committee commends the Energy Research and Development Agency for cooperative support of the electronic identification of Livestock project at the Los Alamos Scientific Laboratory.

Following a report by Dr. E. C. Roukema of Veterinary Services of the United States Department of Agriculture the Committee recognizes and commends Veterinary Services and Meat and Poultry Inspection Service of the United States Department of Agriculture on the increased efficiency and effectiveness of their current market cattle identification and market cattle testing programs.

Dr. Keith Farrell of Agricultural Research Service of the United States Department of Agriculture reported on his work on the fraudulent alteration of horses and projects that use of certain marks of signalment may offer a method of detection of such frauds.
REMOTE TEMPERATURE MONITORING
IN ANIMAL HEALTH MANAGEMENT

G. L. Seawright, DVM, PhD

ABSTRACT

The recent development of an implantable passive transponder with electronic temperature and animal identification capability provides for new applications of body temperature information in the management of animal health. Subdermally-implanted transponders have provided reliable, maintenance-free temperature data for at least 10 months. Limited evidence indicated that silastic-encapsulated transponders were accepted by the animal as an inert material and did not migrate from the initial implant site. As a tool for detecting fever in diseased animals, passive-remote temperature telemetry could be useful in the control of epidemics from the livestock producer through channels of commerce to the packing plant. Temperature telemetry also has potential as a diagnostic aid for recognizing characteristic shapes of febrile response curves, thermal phenomena relating to specific hypersensitivity reactions, and for determining the optimum time for collecting diagnostic specimens. Temperature telemetry may also aid in the detection of stress and heat stress and thereby alert the stockman to the need for corrective action to be taken. Detection of ovulation by temperature telemetry may be useful for determining the optimum time for breeding or artificial insemination. Recognition of thermal markers for disease and stress resistance in breeding stock could be instrumental in the development of livestock that are tolerant to these effects. The importance of the implant site is discussed and arguments for and against several sites are presented.

INTRODUCTION

Changes in body temperature signal a variety of physiological events in health and disease. Several conditions which are characterized by variations in body temperature are reviewed in this article and suggestions are offered on how the detection of thermal phenomena by temperature telemetry would be of benefit in the management of animal health.

Homeostasis in warm-blooded animals is controlled by thermosensitive neurons in the preoptic region of the anterior hypothalamus. The hypothalamic thermoregulatory center behaves like a "thermostat" and is capable of responding to temperature increments as little as 0.01°C (9). Body temperature is finely balanced around a "set point" by the action of thermosensitive neurons which fire and excite either heat conservation or heat dissipation mechanisms (5).
Normal variations in body temperature occur which are related to the time of day. These are designated, ‘diurnal variations’ and may reflect a link between the thermoregulatory mechanisms and the mechanisms controlling sleep and awakening (3). In cattle, diurnal variations are about 0.5°C (29) with temperature minima and maxima occurring in the morning and afternoon, respectively (Fig. 1). Additionally, short-term variations occur which are of higher frequency but usually of lower amplitude (Fig. 2). Normal body temperatures of homeotherms can be influenced by a variety of factors, including age, sex, season, time of day, environmental temperature, exercise, eating, digestion, drinking (3), emotional arousal (22), and sight of feed (10). Of greater interest, from the standpoint of animal health management, are the temperature variations which occur in disease, stress, and physiological events relating to reproduction.

TEMPERATURE TELEMETRY

It is clear from the foregoing that an abundance of useful information is available from body temperature. Unfortunately, the only practical method currently available to the stockman for measuring the temperature of animals is the clinical thermometer. Although the thermometer is a universal tool, its use requires animal restraint and only few daily measurements are practical.

An important advance in temperature monitoring in man and animals has been the advent of remote monitoring by radio-telemetry. Numerous battery-powered devices have been designed and used to convert temperature into an electrical signal that can be telemetered to a remote receiver, amplified, and recorded. However, experience with conventional radio-telemetric systems show that as much time, or more, can be spent solving technical problems relating to equipment on the animal as on the collection of useful information (17). Consequently, remote sensing of temperature has not found wide-scale use outside of the experimental setting.

However, the recent development of an implantable, electronic identification and temperature monitoring transponder at the Los Alamos Scientific Laboratory provides for new applications of temperature information in animal health management. The new system, to be practical for wide-scale use in the food animal industry, needed to meet the following requirements (36): 1) passive (no batteries); 2) remote sensing (animal restraint not required); 3) capable of identifying individual animals; 4) error-free; 5) suitable for direct input into a computer; 6) long life; and 7) low cost. Available experimental data indicate that the passive transponder meets many, and perhaps all, of these requirements.

Experiments with temperature-only transponders, implanted in
cattle at the Veterinary Services Laboratories in Ames, Iowa, showed that after 10 months, reliable temperature data were still being obtained. Limited data indicate that within a few weeks after silastic-coated transponders are implanted, they become enclosed in a thin fibrotic capsule. Histologic examination of a capsule removed from a steer seven months after the implant was installed, indicated that it consisted primarily of semi-mature, fibrous connective tissue and mononuclear cells. No tissue reaction characteristic of immunopathologic organ or tissue rejection, or inflammatory responses typical of those evoked by chemical, physical, or microbial irritants, were observed. These findings indicate that the transponder was accepted as an inert material (D. R. Cassidy and W. D. Taylor, unpublished). In four animals studied, there has been no measureable migration after 10 months from the time the implants were installed. These observations indicate that implanted transponders can provide maintenance-free temperature information over reasonably long periods of time.

BENEFITS OF REMOTE-PASSIVE TEMPERATURE MONITORING

The benefits that might be derived from electronic temperature monitoring in food animals depend largely on the species and the type of industry being served. Since the distance over which present generation transponders can be remotely activated to transmit temperature data is about 30 feet, the frequency of temperature measurements will depend on whether the animals in question are at range, in a feedlot, or in confinement. Some ideas of how electronic temperature monitoring might be used under these varied circumstances are offered in the following discussion.

Fever

Fever is perhaps the best-known characteristic of disease. It results from the effects of endogenous pyrogen on temperature sensitive neurons in the thermoregulatory center. Endogenous pyrogen, which is released from phagocytes exposed to activators such as bacterial endotoxin, viruses, bacteria, antigen-antibody complexes, steroids or hypersensitivity reaction products, acts to elevate the set point to a higher level around which heat loss and gain are again finely balanced (5).

If an electronic method for identifying febrile animals is widely accepted, it could be a valuable tool for controlling epidemics, from the producers, through channels of commerce to the packing plant. Temperature telemetry would allow livestock producers to identify sick animals early in the course of infection and facilitate the rapid isolation, diagnosis, and treatment of these animals. As a result of early isolation of diseased animals, potentially explosive outbreaks
of infectious diseases might be minimized or even stopped. Early fever detection in implanted sows in farrowing houses could be instrumental in the control of devastating outbreaks of transmissible gastroenteritis or pseudorabies. Similarly, early detection of primary sources of mastitis in milking parlors or infectious bovine rhinotracheitis in feedlots could lead to the prevention of sizable economic losses. Post-parturient metritis, a major cause of reproductive failure in dairy cattle, is characterized by an ephemeral fever early in the course of the disease (57). Early detection and treatment of afflicted cows would result in improved breeding performance and, possibly, salvage of the animal’s reproductive future. Should exotic diseases such as foot and mouth disease, rinderpest, or contagious bovine pluero-pneumonia be introduced into the marketplace, rapid identification of infected animals and computer traceback to the herd of origin could be a key factor in the control of industry-crippling epidemics. An example of fever detection in cattle by telemetric methods is given in Figure 3.

Temperature telemetry could also be used as a diagnostic supplement. Diagnosis of tuberculosis in cattle can be made on the basis of an acute hyperthermic response which follows the injection of tuberculin (19). This response was commonly used by regulatory veterinarians to diagnose tuberculosis but was abandoned, largely because the required temperature measurements were cumbersome to obtain. However, electronic temperature monitoring could make the hyperthermic response a practical diagnostic tool. Figure 4 shows a continuous record of telemetered tympanic membrane temperatures of a tuberculous cow intravenously injected with tuberculin (R. D. Angus and R. VanDeusen, unpublished). The hyperthermic reaction began within minutes after the injection, peaked in 3.5 hours and was over in 8 hours. Temperature maxima were about 3.5°C above normal. As a diagnostic technique for tuberculosis or, perhaps Johne’s disease (46), temperature telemetry is appealing because it is reasonably rapid and requires only one handling of test animals.

Temperature telemetry would also be of diagnostic value for determining the optimum time for isolating causative agents from infected animals. The use of temperature-telemetry by McVicar, et al. (49) revealed a temporal relationship between viremia and temperature in deer experimentally infected with foot and mouth disease virus. A temporal relationship between viremia and temperature also occurs in horses infected with Venezuelan equine encephalomyelitis (VEE) virus (34, 43). Since blood is the most reliable source of virus in VEE-infected animals (42), temperature telemetry would be of use for rapidly identifying the best donors for diagnostic specimens.

Where the collection of continuous or semicontinuous temperature records is possible, the shapes of febrile response curves may be of
diagnostic value. For example, infection of cattle with bovine virus diarrhea virus is commonly accompanied by a characteristic diphasic febrile response curve (19). Baldwin, et al. (6) have suggested several other diseases of livestock for which temperature profiles would be of diagnostic value.

Temperature telemetry may also provide an early alert for abnormal temperatures associated with non-infectious diseases. Metabolic disorders, such as lactation tetany in cattle and paralytic myoglobinemia in mares, are accompanied by fever while parturient paresis of cattle is characterized by hypothermia (19). In many instances, the outcome of these diseases depends on early recognition and treatment of the affected animal.

**Stress**

Although the stress or "fight or flight" syndrome has important survival value, its effects in food animals can be devastating. Meat quality may be seriously affected in swine that have experienced transport stress shortly before slaughter (31, 35). Stress may also be accompanied by depression of the immune system (25, 64) and increased susceptibility to infectious diseases. Shipping fever in cattle, now the most costly disease of food animals in the United States (4), is commonly regarded as a stress-related syndrome. Recrudescence of latent infections, such as infectious bovine rhinotracheitis, may also accompany stress (61).

If stress could be detected in livestock by temperature telemetry, it would assist the stockman in identifying and, thus, removing or alleviating the stressor. The stress reaction (60) is accompanied by an arousal of the sympathetic nervous system which effects the redistribution of blood from the skin and splanchnic regions into the main muscle masses (24). This results in changes in body temperatures. Figure 5 shows a semi-continuous temperature record of a steer with a subdermally implanted transponder. The steer was held in a room maintained at 18.5 ± 2.5°C. The data show an abrupt drop in skin temperature which coincided with caretaker activity in the animal's room. Thus, even limited arousal of the animal resulted in significant changes in skin temperature. From the data, it can also be seen that the drop in skin temperature was followed by an increase in deep body temperature. Early detection of such alterations in body temperature of livestock could signal the need for deleterious conditions to be abrogated.

**Thermal Stress**

Environmental heat stress (47, 56) causes great economic losses in food animals throughout the tropical and subtropical regions of the world. Meat production in cattle (23, 63), swine (39), and
poultry (51) may be severely reduced in stress-prone animals. Milk yield from dairy cattle in the Gulf (58) and southwestern (70) states is seriously depressed during the hot summer months. In addition to reduction in yield, heat stress in dairy cows may also result in lowered nutritional quality and deleterious changes in storage and processing properties of milk (14, 33).

Heat stress also adversely affects fertility in food animals. There are numerous reports that low conception rate is a principal factor limiting production in tropical countries (65). In cows, high environmental temperatures may reduce the duration of estrus (50) or even stop the estrous cycle (65). In bulls, as little as 12 hours of heat stress at 40°C reduces spermatogenesis and increases the number of abnormal spermatozoa, sometimes with damage to the seminiferous tubules (62); semen quality may be permanently damaged in some animals (27).

Major economic losses resulting from heat stress may also be experienced in sheep because of infertility (2), embryonic death, dwarfing of lambs, and diminished quality of wool (55). Heat stress in swine may result in fewer pigs at birth, a higher rate of still births, and a reduction in litter size and weights (53).

Heat stress is marked by sustained body temperatures that are abnormally high (14). However, by reducing body temperatures in livestock long enough for the thermoregulatory mechanism to gain control, it is possible to renew normal temperature balance for a few hours, even if ambient temperatures reach stress-inducing levels (63). Although thermal stress can be prevented or diminished by air-conditioned structures, it is argued that the cost-benefit analysis is not generally favorable under present conditions (63). However, Roussel and Beatty (58) have shown that potentially cost-efficient cooling of just the head, neck, and inspired air of individual dairy cows during stressful summer conditions, resulted in an average increase in daily milk yield of 19%. Similarly, when feedlot steers exposed to environmental temperatures of up to 47.8°C were artificially cooled by sprinkling or by evaporative cooling, average daily gains improved by 1.6% and 15%, respectively (54).

Environmental temperature alone is not an absolute measure of the stress threshold since heat stress is also a product of humidity, air movement, and individual susceptibility. It is possible that in milking parors, farrowing houses, or other confinement facilities electronic feedback signals from transponders could be made to trigger devices for cooling individual animals in danger of thermal stress. Detection of approaching stress in livestock in feedlots or other open facilities could alert the stockman to the need for mass-cooling on a herd basis. If the cooling devices could be powered by solar energy, the cooling capacity would be proportional to the stress-
inducing conditions. Under these circumstances, the cost-benefit ratio could become very attractive.

*Thermoregulation and Reproductive Physiology*

There have been many reports that ovulation and parturition are accompanied by changes in body temperature. It is estimated that approximately eight million cattle annually are artificially bred but that this number might increase to thirty million if ovulation could be determined more reliably (6). Wrenn, et al. (71) showed that vaginal temperatures of cattle began to drop a few days before estrus, reached a low point two days before estrus and then rose sharply on the day of estrus. Of interest was the frequent observation that body temperatures were depressed in cows during missed or silent heats and it was often possible to note a low point when estrus would have been expected. In agreement with these results were the recent findings of Maatje and Rossing (48) who reported that in 16 of 19 cases studied, there was an increase in milk temperatures of at least 0.3° C during estrus. Tsutsumi, et al. (66) also found that rectal temperatures in swine were lower during estrus than during either the pre- or post-estrus period. These studies suggest that temperature telemetry may be a promising tool for determining the optimum time for breeding or artificial insemination.

There are conflicting reports on the usefulness of body temperature for predicting impending parturition. Weisz (67) reported that a rapid fall in body temperature reflected impending parturition in the cow, goat, bitch, and mare. Others argue that temperature changes are of limited value for predicting parturition in the cow (66) or goat (40). There is general agreement that the body temperature of swine sharply increases at the time of parturition but that temperature phenomena are not reliable indicators of impending parturition (6, 41, 67). It should be cautioned, however, that all of these studies were based on once- or twice-daily temperature measurements with conventional clinical thermometers. Recently, Bligh, et al. (16) have shown that continuous temperature records, obtained by radio-telemetry, revealed significant increases in body temperatures of alpacas just before birth. Ewbank (26) made a similar observation in the cow, based on conventional temperature measurements, but his limited data were not statistically significant. This suggests that passive-remote temperature telemetry may reveal promising new information concerning the prediction of impending parturition.

**BREED IMPROVEMENT**

Ideally, livestock diseases are best prevented by developing, through selective breeding, animals that possess heritable resistance
to disease. Most North American cattle are descendants of European (Bos taurus) breeds (63, 69). Further breed development in this country and modern methods of intensive animal production have not allowed for the selection of individuals that possess traits that favor survival as well as high productivity (33). On the other hand, tropical (zebu) breeds of cattle (Bos indicus) have followed an evolutionary path that has favored disease and stress (1) tolerance but not, necessarily, high productivity (28). It has been argued that a vigorous, widespread campaign of mixing and selective breeding is needed to combine the best qualities of both Bos taurus and Bos indicus breeds (28). The pace at which such a campaign will progress may hinge on the availability of objective methods for evaluating progress. Although productivity can be readily quantified, objective methods for evaluating resistance to environmental effects are more difficult to come by. Body temperature could prove to be a reliable marker for desirable disease and stress-resistance traits. A capability for detecting these markers by electronic means may, therefore, serve to "expedite" evolution.

Disease Resistance

Fewer patterns in animals experiencing infectious diseases may provide clues to an individual's innate resistance to infection. Callow and Pepper (20) have shown that fever in cattle experimentally infected with Babesia argentina varied directly with severity of disease. They concluded that fever was a sensitive index to the number of parasites within the animal and that it was superior to the standard criteria, parasitemia and anemia, for quantifying the host-parasite relationship. They concluded that fever was easier to measure than the other criteria and was subject to fewer risks of extraneous effects, error and subjective judgment.

As indicated, stress may be accompanied by deviations in normal body temperature and it often precedes the onset of infectious disease processes. A simple method for monitoring animals subjected to stressful situations, such as transport or parturition, would provide useful information for the selection of stress-resistant breeding stock. Shipping fever in cattle is, economically, the most important livestock disease in the United States; yet, it affects a minority of the animals at risk. Similarly, outbreaks of pseudorabies (7) or transmissible gastroenteritis (80) in farrowing houses may result from reactivation of quiescent infections in some sows experiencing the stress of parturition. The question arises, could the detection of a thermal marker for stress be of help in breeding away from the problem?
Heat Tolerance

One of the most pressing needs in protein-deficient regions of the world is the development of highly productive livestock that can tolerate hot environments. Francis (28) pointed out that the development of such cattle should be possible by proper mixing and selective breeding of Bos taurus and Bos indicus breeds but that objective methods are needed for evaluating the products of the program. Zebus are heat tolerant because of their ability to 1) dissipate heat by sweating and panting; 2) control heat production; and 3) resist heat uptake because of length and lie of the haircoat (52). In the search for heat-tolerant breeding stock, these qualities are difficult to quantify outside of the laboratory. A simple alternative would be electronic detection of body temperature markers. Morning rectal temperatures are lower in heat acclimatized than non-acclimatized calves (12, 13) and morning rectal temperatures in Zebu cattle are lower in the summer than in the winter (38). It has been suggested that the lower morning temperatures may reflect a thermo-regulatory advantage in the stress-tolerant animal (13). If this characteristic proves to be a reliable marker for thermotolerant genotypes, temperature telemetry would be of value in identifying individuals bearing the marker.

The search for a genetic solution to the thermal stress problem of the livestock industries in the heat-prone regions of the United States may lead to the concomitant development of a valuable export market. It has been pointed out that the developing countries contain 70% of the world's population and 60% of its livestock, but produce only 20% of the world's protein (28). If the growing need for animal protein is to be met, it is necessary that livestock be developed that are both productive and suited for survival in hostile environments. Any tools that can speed this process are badly needed.

IMPLANT SITE

Body temperature varies from one part of the body to another (3, 65). Therefore, a balance between meaningful body temperature indices and accessibility of the transponder to the interrogation beam requires careful selection of the implant site. The most common site for measuring deep body temperature has been the rectum (65). Although some (3) feel that rectal temperatures may be regarded as a good index of a true steady state in body temperature, others (9) question the physiological significance of measuring body temperature at a site where there are no important thermoregulatory structures. It has been pointed out (10) that in ruminants, rectal temperatures are affected by rumen metabolism and ambient temperatures and, therefore, are not reliable indices of the regulated temperature. We have installed a transponder in the pelvic cavity of a steer, between the rectum and sacrum. This site can be ap-
proached through the skin, lateral to the site, or from beneath the tail, caudal to the site. Installation via the latter approach is quite simple but extreme caution must be exercised to avoid penetration of the dorsal wall of the rectum. This problem, in addition to the vulnerability of the site to infection and to signal attenuation through the sacral bones, suggests that the pelvic cavity is not an ideal site for routine use.

In cattle, the rumen has been considered as an implant site because of the ease with which implants can be installed. However, heat generated by intraruminal microorganisms may produce rumen temperatures 2° C, or more, above body temperature. Temperatures may vary by the same amount in different parts of the rumen. Further, rumen temperatures vary with the amount and temperature of ingested water (68). Finally, signal attenuation for rumen-implemented transponders is probably too severe to be mitigated by practical means.

Most of the transponders we have installed in cattle have been subdermally implanted, caudoventral to the withers. This site is easy to approach and, in our experience, has caused no particular problems with signal attenuation. Although skin temperature is not always representative of deep body temperature and it is significantly influenced by ambient environmental temperature (15), a dearth of information on skin temperature physiology makes it difficult to fully comprehend its potential value.

The ear canal is an attractive site for monitoring animal temperatures because of its proximity to the hypothalamic thermoregulatory center (8). In cattle, tympanic membrane temperatures are considered superior to rectal temperatures (10, 11, 21, 32) because they more accurately reflect rapid changes in deep body temperature and are more resistant to influences of the lower gut (32). As a site for implanting transponders, however, the ear canal suffers from the requirement that the device be externally mounted, with the attendant risks of damage or displacement.

Bligh, et al. (18) reported that temperatures from thermistors embedded 7-8 cm into the muscles of the dorsocaudal area of the neck were in agreement with rectal and carotid artery temperatures. They concluded that temperatures from the neck site were satisfactory measures of deep body temperatures. If future transponders can be configured to permit the thermistor to be implanted to a depth of 7-8 cm, lateral to the dorsal processes of the second or third thoracic vertebrae, and the antenna to be placed subdermally, at the withers, this may provide the needed mix of meaningful temperature measurements and accessibility to the signal.
CONCLUSION

From the foregoing, it is obvious that remote temperature monitoring holds great potential as a new tool in the management of animal health. However, much more work needs to be done before this potential is fully realized.

ACKNOWLEDGMENTS

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Fig. 1. Continuous remote ear-canal temperature record of a normal steer. Points are hourly means of measurements taken at 60 s-intervals (from Seawright et al. (59)).
Fig. 2. Continuous ear-canal temperature record of a normal steer. Points are 5 m means of measurements taken at 60 s-intervals (from Seawright et al. (59)).

Fig. 3. Febrile response of a steer experimentally infected with infectious bovine rhinotracheitis virus. Note that the amplitudes of some diurnal variations are amplified as a result of the fever. Points are hourly means of 60 s-interval measurements (adapted from Seawright et al. (59)).
Fig. 4. Acute thermal response of tuberculous cow after intravenous injection with tuberculin. Points are 5 min means of measurements made at 60 s-intervals (R. D. Angus and R. Van Deusen, unpublished).

Fig. 5. Skin and deep-body temperature changes of a steer following caretaker activity in the animal’s room. Skin temperatures were monitored with a subdermally-implanted transponder and deep body temperatures were monitored with an ear-canal thermistor probe.
REFERENCES


REMOTE TEMPERATURE MONITORING


BEEF IMPROVEMENT AND REMOTE IDENTIFICATION

Robert C. de Baca, PhD

I'm highly flattered to be asked to speak about the topic at hand. I feel that electronic (remote) identification of livestock is one of the most exciting and challenging innovations of the century. I am intrigued with the new technology that is coming available for as I told Dr. Hensley, I've been searching ten years for someone to discover the secret to electronic identification WITHOUT BATTERY LIFE PROBLEMS. The transponder concept gives the entire idea a new surge of possibility.

I'm intrigued with the potentials of electronic identification because of what it will do in health management which is the primary interest of this audience. But as a geneticist and a management consultant, my interest is vastly broader. I foresee remote identification being used in genetic evaluation, in assessing growth patterns and indeed in helping determine the nutritional management of cattle.

I must be pessimistic at the onset for all my enthusiasm is being expressed at a time when the prices of cattle are at all-time catastrophic levels. The financial health of the beef industry is BAD. Innovation is not part of today's tempo for indeed the industry is clawing to survive. Couple the drought and low prices and it spells disaster—now going on three years of it.

It will be difficult to sell the cow calf men on electronic identification right now because of the horrible cash flow positions most are in. It is not a matter of disinterest but of despair. Nevertheless, there is a tomorrow and the prototypes will come into availability about the time the price cycle changes.

The practical uses of remote identification are many. If the price of the reader units can be kept reasonable, the systems will revolutionize cattle breeding and management methodology. They will be big labor savers and will add a great deal of precision to evaluation and management.

I will pass over the value of remote identification in remote temperature measurement because it has been thoroughly treated in this conference. Its value is obvious and I am impatiently awaiting the devices to become readily available and used.

Look now however at the genetic aspects of remote identification. During the past twenty five years there has been an incessant effort to orient the cattle industry toward more systematic genetic improvement. The systematization has included identification of sires, dams and offspring. The methods have included tattoos, hot brands, freeze brands, metal ear tags, rubber ear tags, neck chains and brisket tags to mention several. Most have been utter failure.
The most successful has been to freeze brand, tattoo and double ear tag with rubber tags. Still there is often a problem of legibility caused by erasure, distance or hair growth.

The next step after identification has been to record matings, to record birth dates and weights and then to wait for the calves to become of weaning age—at which time there was (is) a great round up for weighing. Each calf has to be fought and stressed into a weighing crate—ONCE—to evaluate his own growth, the producing ability of his dam and the transmitting ability of the sire. Again when the animal reaches one year and often again at 18 months it is weighed—ONCE—to determine what its growth rate has been. And in spite of the labor and slowness of weighing and the inaccuracy of single weights great strides have been made in changing cattle. We are selecting growthier cattle—we have added much precision to our estimates of genetic merit. We have developed elite herds with these tools—but they are too imperfect, too crude.

When I think of remote identification of beef cattle, I think of electronic weighing in the same thought and of electronic recording of the resulting data (identified). I visualize the day when cattle will walk from pasture to lot through a passage that is set on load cells. The roof of the passage would contain a scanner that would read ID as the animal passed through and a tape or telephone recorder would record ID and weight when the load cells or scanner activated the reader. With no effort except in building the unit and changing tapes one can keep a record of weight changes on cows and bulls and of growth curves of calves. How much more accurate could our breeding programs be if we would record such data daily, weekly, biweekly or monthly as the case may be. The frequency of said readings would be in accordance with whatever the owner deemed useful or practical. Won't it be great some day to say “I think I'll take weaning weights today, flip the switch to activate the scanner, load cells and recorder in all pastures?” Won't it be great to check the weights of bulls on test or steers on feed on a given intermediate date to record the adequacy of their growth or their rations? Won't it be great to weigh the cow and calf periodically to check relative producing efficiency of the cow?

Various attempts are being made today to measure feed consumption in very very few cattle to determine efficiency of feed usage. There is one electronic unit that appears to be useful, however it is very limited as to number of animals that can use each unit. Individual identification of each animal (electronically) will broaden the possibilities of measurement of feed efficiency. There are some real problems today in the measurement of feed efficiency. Labor costs to date in measuring efficiency have made the practice impractical. The high relationship between growth rate and efficiency
gives 80% of knowledge of efficiency by knowing growth as through measurement of efficiency itself. With electronic identification we can go after the other 20% without horrendous cost. One of the greatest dangers in measuring feed efficiency lies in data comparison. There is a tendency to read absolute data and to compare animals on them. Differences in metabolic weights of animals influence efficiency both in maintenance and in production requirements. Care must be taken to adjust these out of the data either by pre-programing mini

Whereas the genetic possibilities are intriguing, a greater potential exists commercially which utilizes exactly the same methodology. This is in the area of ration adjustment for range (or even feedlot) cattle. In the industry there are persons (and I am one) who can walk or drive through pastures, fields or pens of cattle and visualize the need for ration changes. This requires vast experience—and many cattlemen almost never learn it. For all of the ability that these people have to see livestock condition—the ability is not good enough. Before an animal shows the impact of need, it has undergone some stress or some physiological deprivation. Electronic identification and on-the-spot weighing of cattle on pasture can avoid the inaccuracy of “visual” ration changing. One could set up load cells at water fountains and scan weights weekly or so to determine needed ration adjustments. This aspect of electronic management offers the greatest market opportunity and probably could do more to sophisticate cattle production nationwide or world wide than could any other innovation.

In summary and without a great deal of detail, the beef industry stands to gain greatly in genetic and nutritional management from proposed electronic identification. In the genetic aspects the physical identification itself as well as the related measurement of growth curves and growth rates are of intrigue. In general management, the adjustment of rations through a precise knowledge of weight change trends will be a great boon. The industry will benefit from remote identification.
VESICULAR STOMATITIS IN MEXICO

John Mason, DVM; Alfonso Herrera Saldaña, DVM and Willie Joe Turner,* DVM

INTRODUCTION

Vesicular stomatitis (VS) is a viral disease which causes mouth, foot and teat lesions in cattle, horses and swine, and less frequently, an influenza-like illness in man. Vesicular stomatitis is grouped with the "vesicular diseases" of livestock, which include foot-and-mouth disease (FMD), vesicular exanthema of swine and swine vesicular disease (SVD). In addition to being a cause of economic loss in beef and dairy herds, because of loss of weight and a drop in milk production in affected animals, the disease is of paramount importance to animal health authorities because of the clinical similarity of the lesions with those produced by FMD.

Vesicular stomatitis in livestock is caused by two antigenically distinct rhabdoviruses, New Jersey and Indiana, isolated in 1925 and 1926. In addition to the original Indiana isolate known as Indiana 1, two additional subtypes have been isolated in recent years, Cocal or Indiana 2, and Alogoas or Indiana 3.

Although VS may exist in other parts of the world, the disease appears to be indigenous to the Western Hemisphere, and has been reported in Canada, the United States, Mexico, Central America and most of South America. Hanson reviewed the early history of VS and the epizootics reported in North and South America up to about 1950 and has reviewed the current theories on the natural history and epizootiology of the disease. Large VS outbreaks have been described in the United States in Colorado in 1945, in Wisconsin in 1949, in Oklahoma in 1957, in Texas in 1959, in Georgia and Alabama in 1963, in Texas, Oklahoma, Arkansas and Missouri in 1964, and in Colorado and New Mexico in 1965. More recent outbreaks have been summarized by Jenney.

Vesicular Stomatitis in Mexico

Vesicular stomatitis outbreaks had been reported in Mexico in the 1930's and 1940's but the disease was not under close surveillance until the discovery of FMD there in 1946. In fact, it appears that the first cases of FMD in Mexico may have been mistaken for VS.

Foot-and-mouth disease was detected in the State of Puebla, Mexico in December, 1946, and a joint Mexican-American Commis-

*From the Mexican-United States Commission For the Prevention of Foot-and-Mouth Disease—Dr. Mason, Veterinary Medical Officer, U.S. Section; Dr. Herrera, Technical Sub-Director, Mexican Section; Dr. Turner, Assistant Co-Director, U.S. Section.
tion* was formed soon afterwards to deal with the outbreak. The disease was finally eradicated in 1954, but the Joint Commission has continued its activities since that time.

Since VS was enzootic in parts of Mexico and is clinically indistinguishable from FMD, the Commission was concerned from the very start of the campaign with investigating all reported cases of vesicular disease in livestock. Foot-and-mouth disease has not appeared again since 1954, but a large number of VS outbreaks have been investigated and recorded. The complement fixation test (CF) was first used routinely by the Commission in Mexico in July 1949,17 to differentiate FMD disease from VS, and laboratory and field data relating to the Commission's activities have been maintained since that time.

The following report is an epidemiological analysis of the data accumulated by the Commission on VS in Mexico for a 27-year period from 1949 through 1975.

MATERIALS AND METHODS

The measures used by the Commission for surveillance of vesicular disease have varied considerably during the 27-year period. From 1949 to 1954, when FMD was still present in Mexico, periodic routine visits were made, usually on a monthly basis, to all livestock premises in areas which were under quarantine as a result of the FMD outbreak. From 1954 to 1958 practically no field inspections were carried out. From 1958 through 1975 all reported cases of vesicular disease anywhere in Mexico were investigated without delay by a small staff of Mexican and American veterinarians based in Mexico City.

The basic laboratory procedures employed during the 27-year period also have gone through various changes. The CF test, using vesicular epithelium from suspect animals as the test antigen, has served as the basic laboratory test throughout the entire period. Up to 1960, bovines were used for inoculation when field samples were insufficient for a CF test, or when the test was suspicious or equivocal for FMD. Mice have been used as test animals since 1960, and tissue culture techniques were introduced in 1969. In cases where the initial CF test with vesicular epithelium was negative, or if the sample was insufficient for the CF test, suckling mice were inoculated intraperitoneally (IP), and 15-18 day old mice intracerebrally (IC). Primary swine kidney and VERO (green monkey kidney) tissue cultures also were inoculated with the field antigen.

In the CF test, the field antigen, or brain tissue of mice inoculated IC or muscle tissue of suckling mice that died after inoculations, or material from tissue cultures that showed cytopathogenic effect, was run against 10 different types of antisera, seven for foot-and-mouth disease (A, O, C, SAT 1, SAT 2, SAT 3 and Asia I) and three for VS (New Jersey, Indiana 1 and a pool of Indiana 2 and Indiana 3). Antiserum for swine vesicular disease also has been used since 1974 if the field sample was from swine.

From 1962 to 1969, blood samples were collected from suspect animals, in addition to vesicular tissue, and CF tests were carried out for the presence of serum antibodies to the NJ and Indiana 1 vesicular stomatitis virus (VSV).

RESULTS

Geographical Distribution

The low-lying coastal plain made up of the State of Veracruz, and adjoining parts of Oaxaca, Tabasco and Chiapas can be considered an area where VS is enzootic in Mexico. Since 1949 69% of the VSV positives were found in this area, and 62% of the investigations were carried out there, even though only about 25% of the cattle population of the country is found there.

Although VS is seen in the Veracruz area practically every year, the disease has been found sporadically, in epizootic appearance, in other parts of the country, most notably in the States of Jalisco, Michoacan, Hidalgo, Guerrero and Colima. In some areas the disease was reported only once or twice during the 27-year period under review (1949-1975). (Maps I, II, and III). Even in the enzootic areas, VS is not reported consistently every year, either on the same ranches or in the same municipios.

Seasonal Distribution

When the number of outbreaks positive for the NJ type of VSV are tabulated by month of collection of the samples, a rough correlation can be seen with rainfall: the number of outbreaks increases with rainfall, reaches a peak at the height of the rainy season in September and then drops sharply at the end of the rainy season (Graph I). A correlation with rainfall is not seen with the Ind 1 type of VS.

Climatic Conditions in Enzootic Areas

The area in Mexico where VS appears to be enzootic is characterized by a tropical rainy climate with no cool season, and with either no dry season or with a short dry season with high total rainfall. The area has a mean annual temperature of 25° C, is humid
or even perhumid, and from June to November, the months of highest VS incidence, usually has a water surplus. Vesicular stomatitis is seen only sporadically in the arid and semiarid regions of Mexico or in the mountainous areas in the interior where the mean annual temperature is usually between 15°-20°C.¹⁸

**Distribution of Vesicular Stomatitis by Altitude**

Although the great majority of the cases of VS in Mexico from 1949 to 1975 were found at low altitudes in coastal areas, particularly in Veracruz, a limited number of cases and outbreaks have been seen in the interior of the country, at altitudes ranging up to 9000 feet. From the data available, the enzootic areas are found in the coastal regions, while the scattered sporadic outbreaks are more likely to occur at higher altitudes.

**Differences between New Jersey and Indiana types of Vesicular Stomatitis**

Although the clinical effect produced in animals by the NJ type of VSV is indistinguishable from that seen in Ind 1 type VSV infections, the two virus types appear to be distinct epidemiological entities. The NJ type is more prevalent and more enzootic in Mexico. The Ind 1 type is seen less frequently and is more sporadic and epizootic. The two types are rarely found together in the same herd at the same time, or even in the same area. Except for the 1954 to 1958 period when field activities were limited, the NJ type has been reported in Mexico every year since 1949, except for 1961. However, the Ind 1 type was not reported during the years 1958, 1959, 1960, 1962, 1964, 1966 and 1970, even though the NJ type was diagnosed during these years. During the one year that the NJ type was not found (1961), the Ind 1 type was reported.

Since 1949, during 315 different months when cases of NJ VS were found in Mexico, Ind 1 VS was also found in the same month and in the same municipio (county) only on 19 different occasions (6%). However, in a recent VS outbreak in the Matias Romero area of Oaxaca (September 1975), both viruses were found on two different ranches in the same herds at the same time, although in different animals. These premises were about 20 kms. distant from each other. In another outbreak in swine in Tabasco in October, 1975, both the NJ and Ind 1 viruses again were found on one ranch and, in fact, in the same epithelium sample, in two different samples, from two different animals.

The enzootic area for the NJ type of VS is limited to the States of Veracruz, Chiapas, Oaxaca and Tabasco with more sporadic, epizootic occurrence in the States of Jalisco, Michoacan, Hidalgo, Colima, and Guerrero. A smaller number of cases were found in the
States of Aguascalientes, Coahuila, Colima, Durango, Guanajuato, Mexico, Morelos, Nayarit, Nuevo Leon, San Luis Potosi, Tabasco, Tamaulipas and Zacatecas. The NJ type has never been reported during the 27-year period in the States of Baja California, Campeche, Chihuahua, Queretaro, Quintana Roo, Sinaloa, Sonora, Tlaxcala or Yucatan.

For the Ind 1 type the main enzootic area would also seem to be the State of Veracruz, and the low-lying bordering areas of Oaxaca. A considerable number of positives was found in Guerrero in 1951 and 1952 and the rest of the positives were scattered, isolated findings from Colima, Chiapas, Chihuahua, Jalisco, Michoacan, Morelos, Nayarit, Puebla, San Luis Potosi and Tabasco. Cases of the Indiana type were not reported in the rest of the states during the 1949-1975 period. Indiana 2 and Ind 3 types of VSV have never been detected in Mexico.

Regional Vesicular Stomatitis Outbreaks

Although VS is enzootic in the coastal area of Veracruz and parts of Tabasco, Chiapas and Oaxaca, and cases are found there practically every year, the appearance of the disease in other parts of the country is characterized by its sporadic occurrence, in a scattered and unpredictable manner, and generally on a regional basis. A large regional outbreak of NJ VS was seen in the Isthmus of Tehuantepec area in the latter part of 1975 and some 30 investigations of vesicular disease were carried out during a 3-month period in contiguous areas of Oaxaca, Veracruz, Tabasco and Chiapas, with 80% of the premises visited positive for NJ VSV.

Although a regional outbreak might be seen over a fairly large area, the herds affected in this area usually were scattered within the area, and it was rare to find contiguous ranches affected. The outbreaks were of very short duration, all the cases on an affected premise usually appearing within a one or two-week period. Even on a regional basis, newly affected cases or herds were rarely found after a 1-2 month period.

Attack Rates for Vesicular Stomatitis

The number of cattle affected with clinical signs in herds with VS between 1970 and 1975 was tabulated. Of the total 175 herds, 127 had NJ VS and 48 the Ind 1 type VS. In the herds affected with the NJ type, of a total cattle population of 17229, 1492 (or 9%) were reported affected clinically. In the herds with Ind VS, of the total population of 5366, 289 (or 5%) were affected. This gives an overall attack rate of 8% for both types, although the rates in individual herds ranged from less than 1% to 100%.

If the attack rates are tabulated for bovines by site of the lesions,
VESICULAR STOMATITIS

in herds with NJ VS, with mouth lesions only, the attack rate was 7%; where the teats only were affected, the rate was also 7%; for feet only it was 8%; for mouth and feet it was 11%; for mouth and teats it was 9% and for all three it was 12%.

For herds with Ind 1 VS, the attack rate for herds with mouth lesions only was 3%; for teats only it was also 3%; and for both, it was 13%. No foot lesions were reported for Ind 1 VSV.

Horses on premises with VS showed an attack rate of 8% for NJ VS and 4% for Ind 1 VS. Pigs showed a 2% attack rate for NJ VS, and 5% for Ind 1 VS. Neither goats nor sheep have been found affected with VS in Mexico during the period under study.

Of 121 cattle herds affected with NJ VS, animals with mouth lesions were found in 93% of the herds, teat lesions in 24% of the herds and foot lesions also in 24% of the herds. For some 45 herds affected with Ind 1 VS, 78% of the herds had animals with mouth lesions, and 45% with teat lesions. No foot lesions were seen.

Age Distribution of Cases of Vesicular Stomatitis

In 148 cases of NJ VS detected in bovines between 1970 and 1975, the cases were fairly evenly distributed from ages 1-6 years, with only 6% of the cases in animals less than one year of age. In 28 cases of Ind 1 VS, a somewhat similar distribution was seen.

Intervals Between Onset of First Case and Visit to the Affected Premise

Since the primary object of the field investigations was to make a differential diagnosis between FMD and other vesicular diseases, reports were attended as quickly as possible, and usually the affected premises were visited within one or two days after the receipt of the report. It was found that the shorter the interval between the onset of the first case and the subsequent visit and collection of specimens, the better the chances of obtaining positive results for VS. The mean interval for herds positive for VS was 7.5 days, and 12.9 days for herds found negative for VS. The best chance to collect positive samples was to visit the herd within 8 days after onset. A smaller proportion were still positive up to 15 days, but very few after this time.

In herds where the affected animals were found to have some non-vesicular condition, the mean interval between the onset of the first case and the investigation was 22.0 days. As could be expected statistically, the greater the number of samples collected during an investigation, the greater the chance of finding VS. In 203 investigations of herds with vesicular disease, where only one epithelium sample was collected, 39% of 92 herds were positive for NJ or Ind
1 VSV. Where three or more samples were collected 84% of 57 herds were positive.

**Relative Susceptibility of Livestock Species to Vesicular Stomatitis**

On premises where VS was found, cattle were seen to be most susceptible, then horses, followed by swine. Sheep and goats were not found to be affected. On 91 premises with both cattle and horses, where the cattle were affected with NJ VS, horses were reported also affected on 23 of the premises (25%). On 35 premises with both cattle and horses, where Ind 1 VSD was present in the cattle, horses were affected on six of the premises (17%). Cases in horses may be underreported more than in the other species affected, since the Commission may not have been notified of some outbreaks where only horses were affected.

Swine were rarely affected with VS when cattle were affected on the same premises. In 45 premises where the cattle had NJ VS, pigs were reported affected on only one. On two premises where pigs were affected with NJ VS, cattle were not affected. On 18 premises where cattle were found with Ind 1 VS, pigs were reported affected on only one location.

**Analysis of Field Investigations Since 1962**

The primary activity of the FMD Commission in Mexico has been the investigation of reports of cases or outbreaks of vesicular disease in cloven-hoofed animals. From 1962 through 1975, 836 investigations were carried out, with an average of about 65 investigations per year. From 1963, the number has been fairly steady, with a low of 36 in 1963 and a high of 110 in 1966. The percent of investigations positive for VS has also remained quite constant, averaging about 32% per year. In investigations where epithelial tissue samples could be collected, 56% of the investigations were positive for VS. Of the herds positive for VS, 82% were for NJ VSV and 22% for Ind 1 VSV.

The great majority of samples collected during investigations (93%) have been from cattle. A very small number of samples were from horses, pigs, goats or sheep (4%, 2%, 1% and 0.4% respectively).

Positive CF tests for VSV have been obtained with epithelial samples from horses (6 for NJ VSV and 2 for Ind 1 VSV), and from pigs (10 for NJ VSV, 1 for Ind 1 VSV and 2 for both NJ and Ind 1 VSV) but not from sheep or goats.

Of the epithelial samples from bovines, about 90% were from the mouth, 6% from the feet, and 4% from the teats and udder.
VESICULAR STOMATITIS

DISCUSSION

The findings for VS in Mexico generally confirm what has been reported about the disease in other areas.7,11,15,19 The disease is seen in enzootic form in low-lying coastal areas, and in epizootic, sporadic form inland at higher altitudes. The incidence of cases is higher during the rainy season than during the dry season. The NJ type of VSV is more common than the Ind 1 type. Large regional outbreaks are seen but the affected premises are scattered and generally not in close proximity with each other. The great majority of cases are in bovines, with fewer cases in horses and swine. Goats and sheep are not affected. Cattle and horses may be affected on the same premises, but VSD does not seem to occur very often in cattle and hogs at the same time on the same ranch.

The attack rates are generally low, with about 8% of the animals showing clinical signs. The mouth is most usually affected, with lesions less frequently seen on the udder and teats and on the feet. Foot lesions were not seen with Ind 1 VS. Older animals are more likely to be affected.

The mode of transmission of VS is still unknown and data collected in Mexico do not suggest any solution to the mystery. On the basis of clinical cases, the sporadic, scattered appearance of cases and affected herds and the low proportion of animals affected in any single herd would suggest that the disease is not very contagious. Indiana VS virus has been isolated from a variety of anthropods 22 eye gnats,16 and sandflies23) but the difficulty (mosquitoes,20 mites,21) in demonstrating a suitable period of viremia in affected animals would seem to rule out a simple cattle-vector-cattle cycle, for example. Also, the short course in any affected herd and the simultaneous appearance of the disease over large areas is not typical for a vector-borne disease, where a gradual build-up of infection and secondary waves of cases during the usual vector breeding season are more commonly seen.

Heavy rainfall or the existence of a water surplus in an area just before or during an outbreak of VS may be a crucial contributing factor in producing the outbreak. Sporadic outbreaks in arid or semi-arid areas or outside the regular rainy season in humid areas may in fact be related to a period of abnormal out-of-season precipitation. Jonkers26 in his review of the ecological factors noted during VS outbreaks, mentioned heavy rainfall or "wet pastures" as being commonly seen. Whether the humid conditions influence a higher vector density, or in some way cause a change in the environment which activates the virus to produce lesions in exposed animals, or animals already harboring the virus, is not yet understood.
Jonkers\textsuperscript{26} has presented arguments against VS as a vector-borne disease and has suggested that the VS virus is present in the pastures used by affected herds and is triggered to infect animals by favorable and as yet undefined conditions. Johnson\textsuperscript{27} goes further to suggest that VS is a plant virus that may be transmitted in some way to vertebrates, possibly by sandflies, or some type of nonbiting anthropods such as aphids, which are also known to transmit certain plant viruses morphologically similar to the VS viruses.

Serological surveys for VS carried out in other areas have indicated that widespread infection with VS virus is common in enzootic areas, in livestock, wildlife and man.\textsuperscript{28-38} It is very likely that the great majority of the VS infections in livestock, as well as in wildlife species and in man are asymptomatic and it may be that the clinical cases are rare exceptions which are not true indices of the incidence, distribution or basic epidemiology of the disease.

It may be that in enzootic areas VS virus is a common inhabitant of a wide range of livestock and wildlife species, possibly in some latent or masked form, and that the occasional “outbreaks” of clinical cases are the result of some environmental influences which are not related to the basic transmission mechanism nor are necessary for the survival of the virus in nature. It may also be a mistake to assume that because the NJ and Ind 1 types of VSV are morphologically similar, and cause similar clinical lesions, that they necessarily have the same transmission cycle or reservoir in nature.

It would appear that any significant advance in understanding the basic epidemiology of VS will require rather extended, wide-scale ecological investigations. One possible avenue of investigation of VS is to carry out a longitudinal study of a fairly large herd of cattle pastured in a typical enzootic area of Mexico, over at least a 3-5 year period. Utilizing various serological procedures, it should be possible to determine the extent and patterns of infection and possibly permit some correlation with special climatic conditions, vector activity or exposure to certain plants or grasses in the area. If, as Johnson et al\textsuperscript{27} suggest, the transmission of the disease depends on some complex interrelationship between the virus, susceptible mammals, various anthropod vectors and certain plants, then an extensive concomitant ecological study would have to be carried out in the area where the sentinel herd was being followed clinically and serologically.

Although a single case of VS in a bovine is indistinguishable clinically from a case of FMD, on a herd or outbreak basis there are certain points of difference between the two diseases, based on the experience with VS in Mexico, and assuming continued complete susceptibility of the cattle population in Mexico to FMD. First, VS would be more likely to affect clinically a much smaller proportion of the exposed animals than FMD would. Secondly, horses would be af-
fected at times by VS but not by FMD. Swine would be affected much more readily by FMD and with higher attack rates, than with VS, and cattle on the same premises would be more likely to be affected with FMD also, than with VS. Foot-and-mouth disease would appear to be much more contagious and spread more readily in the same herd and to neighboring ranches, and secondary cases and outbreaks would occur over a considerable period of time, rather than almost simultaneously over wide areas, as with VS. Foot-and-mouth disease would affect young stock more readily than VS and the overall mortality would very likely be higher. Any vesicular condition in sheep and goats, particularly with lameness, would be suspect for FMD, since these animals do not seem to be affected clinically with VS in Mexico.

Although any vesicular condition in livestock in Mexico is considered suspect for FMD until laboratory tests can be carried out, the finding of the above herd characteristics for FMD in the course of an investigation would certainly increase the suspicion that the outbreak might be due to this disease rather than VS.
NUMBER OF EPITHELIAL SAMPLES POSITIVE FOR NEW JERSEY VESICULAR STOMATITIS VIRUS

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* NO FIELD ACTIVITIES 1954-1957

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NUMBER OF EPITHELIAL SAMPLES POSITIVE FOR INDIANA VESICULAR STOMATITIS VIRUS*

MEXICO - 1949-1975 - BY STATE

| State             | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | TOTALS |
| Aguascalientes   | 4 | 1 | 1 |   | 5 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 75 |    | 75 |
| Baja California  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0   |
| Campeche         |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0   |
| Coahuila         |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0   |
| Colima           | 4 | 1 | 1 |   | 5 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 10  |
| Chihuahua        | 1 | 1 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 2   |
| Distrito Fed.    |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 3   |
| Durango          |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 10  |
| Guanajuato       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0   |
| Guerrero         | 14| 8 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 26  |
| Hidalgo          | 2 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 3   |
| Jalisco          |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 16  |
| Mexico           |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0   |
| Michoacan        | 3 | 3 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 6   |
| Morelos          |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 6   |
| Navaric          | 1 | 1 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 6   |
| Nuevo Leon       | 3 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 3   |
| Oaxaca           | 3 | 53 | 22 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 88  |
| Puebla           | 2 | 2 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 4   |
| Queretaro        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 7   |
| Quintana Roo     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0   |
| San Luis Potosi  | 1 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 2   |
| Sinaloa          |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0   |
| Sonora           |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0   |
| Tabasco          |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 3   |
| Tamaulipas       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 3   |
| Tlaxcala         |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0   |
| Veracruz         | 1 | 35 | 74 | 47 | 4 | 2 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 130|
| Yucatan          |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0   |
| Zacatecas        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | 0   |
| **TOTALS**       | 1 | 38 | 146 | 82 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 12 | 10 | 0 | 2 | 5 | 346 |

*No Field activities 1954-1957.
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<th>Non Vesicular Disease (INVESTIGATIONS)</th>
<th>Total Vesicular Investigations</th>
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**TOTALS**: 209 - 57 - 71 - 22 - 42 - 59 = 708
FIGURES INDICATE INVESTIGATIONS FOR VESICULAR DISEASES
INVESTIGATIONS POSITIVE FOR VESICULAR
STOMATITIS VIRUS

MAP
LABORATORY-CONFIRMED VESICULAR STOMATITIS IN MEXICO - 1962-1975 - BY STATE

STATES
I AQUASCALIENTES
II BAJA CALIFORNIA
III BAJA CALIFORNIA SUR
IV CAMPECHE
V COAHUILA
VI COLIMA
VII CHIHUAHUA
VIII CHIAPAS
IX DISTRITO FEDERAL
X DURANGO
XI GUANAJUATO
XII GUERRERO
XIII HIDALGO
XIV JALISCO
XV MEXICO
XVI MICHOACAN
XVII Nayarit
XVIII Nueva Leon
XIX OAXACA
XX OAXACA
XXI PUEBLA
XXII QUERETARO
XXIII QUINTANA ROO
XXIV SAN LUIS POTOSI
XXV SINALOA
XXVI SONORA
XXVII TABASCO
XXVIII TAMAULIPAS
XXIX TECACALCO
XXX VERACRUZ
XXXI YUCATAN
XXXII ZACATECAS

I - 13/2
II - 31/19
III - 16/0
IV - 14/4
V - 1/0
DISTRIBUTION OF VESICULAR STOMATITIS (NEW JERSEY TYPE) IN MEXICO, BY STATE, FROM 1949-1975.

Each dot represents a month during which laboratory confirmed NJ type VS was detected one or more times in a particular municipality.
DISTRIBUTION OF VESICULAR STOMATITIS (INDIANA TYPE) IN MEXICO, BY STATE, FROM 1949-1975

EACH DOT REPRESENTS A MONTH DURING WHICH LABORATORY CONFIRMED INDIANA TYPE VS WAS DETECTED ONE OR MORE TIMES IN A PARTICULAR MUNICIPIO.
Graph I

Mexico

Rainfall as related to field investigations positive for vesicular stomatitis 1962 - 1975

- POS. INVESTIGATIONS
- RAINFALL

1962-1975

Number of positive investigations

MONTHS

J F M A M J J A S O N D

Composite total rainfall in inches - 52 localities in Mexico monthly averages over a 5-year period.
VESICULAR STOMATITIS

GRAPH II
MEXICO
INVESTIGATIONS FOR VESICULAR DISEASE
1967 - 1975

4-WEEK PERIODS

<table>
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TOTAL INVESTIGATIONS FOR VESICULAR DISEASE

INVESTIGATIONS NEGATIVE FOR VS
INVESTIGATIONS POSITIVE FOR VS

NO. OF INVESTIGATIONS

4-WEEK PERIODS

1 2 3 4 5 6 7 8 9 10 11 12 13
REFERENCES


THE INFLUENCE OF INFECTIOUS BOVINE RHINOTRACHEITIS VIRUS ON THE FOOT-AND-MOUTH DISEASE CARRIER STATE

J. W. McVicar, DVM; P. D. McKercher, DVM, and J. H. Graves, DVM

INTERPRETIVE SUMMARY

Foot-and-mouth disease (FMD) carrier cattle were mixed with susceptible cattle and exposed to Infectious Bovine Rhinotracheitis (IBR) virus by inoculation or by contact with inoculated animals. Additionally, FMD carrier cattle previously infected with IBR virus were mixed with susceptible cattle and stressed by a series of corticosteroid injections. Transmission of FMD virus from the carrier to the susceptible cattle was not demonstrated in either experiment.

INTRODUCTION

Epizootiologic evidence exists for the transmission of foot-and-mouth disease (FMD) from carrier cattle to susceptible cattle (1) but to date attempts to demonstrate such transmission experimentally have failed (2,3,4). The purpose of the experiments to be described here was to attempt to induce transmission of FMD by exposing carrier cattle to Infectious Bovine Rhinotracheitis (IBR) virus while they were in contact with susceptible cattle.

Materials and Methods.

Cattle. Grade Hereford steers approximately 18 months old were used. Methods of management in isolation rooms have been described (5).

Virus. FMD virus subtypes A, O, C, and the Colorado strain of IBR virus were used. Each virus was passed up to 10 times in primary bovine kidney (BK) cell cultures before use.

Samples taken. Oesophageal-pharyngeal (OP) fluid was taken with a cup probang and immediately mixed with equal parts of Hanks balanced salt solution with 0.5% lactalbumin hydrolysate (HLH) and containing 1000 units of penicillin, 1 mg of dihydrostreptomycin, and 125 units of nystatin1 per ml. Selected samples were treated with tricholorotrifluoroethane (TTE) before assay as previously described (6).

From the Plum Island Animal Disease Center, Agricultural Research Service, U. S. Department of Agriculture, Greenport, New York 11944

Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture and does not imply its approval to the exclusion of other products that may also be suitable.

1Mycostatin, E. R. Squibb and Sons, New York, N.Y.
INFLUENCE OF IBR VIRUS

Nasal mucus was taken with a cotton tipped applicator which was immediately immersed in 5 ml of the diluent described above. Blood was collected from the jugular vein into vials containing heparin solution.

Cell cultures. Virus was isolated in BK cell cultures or occasionally primary bovine thyroid cell cultures under fluid overlay. Viral infectivity was quantitated by plaque assay in BK cell cultures under 1% methyl cellulose.

Plaque reduction tests. Plaque reduction tests were done in secondary BK cell cultures as previously described (7).

Fluorescent antibody test. Secondary BK cell cultures, grown on coverslips in Leighton tubes were inoculated either with the original sample or with fluid harvested from cultures showing cytopathic effect (CPE). After 72 hours incubation at 37 C, the cells were fixed with methyl alcohol and stained with a fluorescein conjugate of IBR specific antiserum.2

Experimental design. Experiment 1. FMD virus was demonstrated in the OP fluid of 6 vaccinated cattle which had been exposed to FMD infected cattle six weeks previously. Two of these carrier cattle, one carrying type A virus and the other type O, were placed in each of three isolation rooms together with two noncarrier cattle. In one room, the carrier cattle were inoculated intranasally with approximately 107 pfu of IBR virus. In another room, the noncarrier cattle were inoculated, and in the third room, all four of the cattle were inoculated. Samples of OP fluid, nasal mucus, and heparinized blood were taken from all cattle before inoculation and then daily for 10 days and at 13, 17, 24, 31, and 38 days from the noncarrier cattle in the first two rooms and from all cattle in the third room. Serum samples were taken weekly from all cattle.

Experiment 2. Six weeks after inoculation of the IBR virus, all 12 cattle from Experiment 1 were inoculated intranasally with 106 pfu of FMD virus type C. Seven weeks later, 7 of the cattle were shown to be carriers of type C virus and 6 of these were selected for additional studies. Three of these carrier cattle were put in each of two isolation rooms and an equal number of noncarrier cattle were added. The carrier cattle were then given 10 daily intramuscular injections of 20 mg dexamethasone.3 Samples of OP fluid, nasal mucus, and heparinized blood were taken from all cattle before the steroid treatment and then daily from the noncarrier cattle for 11 days. Sampling continued from 14-18 days and then at 21 and 28 days. Nasal mucus only was taken from the carrier cattle on the above schedule with OP fluid being taken weekly. Serum samples were taken weekly from all 12 cattle.

1 Kindly supplied by Dr. E. Carbrey, Veterinary Services Laboratory, Ames, Iowa.
2 Azium, Schering Corp. Kenilworth, NJ 07033
RESULTS

Experiment 1. The reaction of the cattle to the intranasal inoculation of IBR virus is shown in Fig. 1. A three to four day febrile reaction was observed in all of the cattle. In the non-inoculated contact cattle, fever was observed 2 to 3 days later than in the inoculated cattle. A cytopathogenic agent, identified by fluorescent antibody test as IBR virus, was recovered from the nasal mucus and/or OP fluid of all cattle generally starting 1 day before and lasting until 2 or 3 days after the febrile response. Infectivity titers of IBR virus in OP fluid samples are listed in Table 1. Treatment with TTE regularly resulted in lower titers for the first 4 to 6 days. Then, with one exception (steer 9), the trend was reversed for a day or so before virus recoveries abruptly ceased. Virus was not detected in any blood sample.

All cattle developed IBR lesions which typically started with hyperemia of the nasal septum followed by the appearance of pale raised plaques approximately 0.5 centimeter in diameter, which eventually sloughed leaving raw bleeding areas. This reaction was accompanied by a mucopurulent nasal discharge which occasionally contained bits of necrotic tissue or blood. The clinical course appeared to be less severe in the contact cattle which did, nevertheless, develop a transient conjunctivitis after 9 or 10 days; a condition not observed in the inoculated animals.

FMD virus was not detected in samples from any of the contact cattle, and plaque reduction tests on their post exposure serums failed to indicate any development of antibody to this agent. As a matter of fact, FMD virus disappeared from the OP fluid of the two carrier cattle which were sampled starting 1 day after inoculation with IBR virus, and did not reappear during the 4 week sampling period.

Experiment 2. We then considered that perhaps the rather severe clinical reaction was in fact detrimental to the transmission of the FMD virus. Therefore, the entire group was infected with a third FMD virus type and a second group of carriers selected. These were to be subjected to steroid stress which has been shown to cause a recrudescence of IBR virus in latently infected cattle and its transmission to susceptible contact cattle (8).

Results of virus isolations from the cattle are presented in Table 2. IBR virus was recovered from all of the treated and contact cattle. Nasal lesions were observed in all treated cattle but not in the contact cattle. The febrile response was minimal in all cattle with temperatures elevated above 103.0 F for only an occasional day in a few animals. Two of the treated cattle developed diarrhea toward the end of the treatment period. Blood was observed in the stools for a day or so and one animal showed tenesmus for about 24 hours. Both animals recovered spontaneously three or four days after the last of the steroid injections. Once again, FMD virus was not detected in
samples from the contact cattle and specific serum antibodies were not demonstrated. The OP fluids of the 6 carrier cattle were examined for FMD virus 7 days after the start of the steroid injections and none was found. The last samples were taken at 28 days and were also negative for FMD virus.

DISCUSSION

So far, attempts to cause transmission of FMD virus from carrier cattle to susceptible cattle have failed. Indeed, an attempt at manipulation of carrier animals by driving them for some distance resulted in the disappearance of the FMD virus from the OP fluid (R. S. Hedger, personal communication). Whether the lack of virus in the OP fluid indicates a complete loss of the virus or merely its disappearance from the area sampled by the drainage of OP fluid and whether or not the virus may subsequently become detectable, are questions which need to be answered.

IBR virus infected cattle by inoculation and contact. The severity of the clinical response observed in Experiment 1, was not expected because all cattle had been vaccinated on the farm of origin with a commercially available modified live virus IBR vaccine.

Probang samples of OP fluid were found to be a very good source of the IBR virus. During the height of the clinical course of the infection, samples of OP fluid and nasal mucus were both positive in nearly all instances but before and after this time, when infectivity titers were low, virus was frequently found in the OP fluid when the nasal mucus sample was negative. The loss of infectivity in OP fluid samples treated with TTE was not unexpected as IBR virus is sensitive to ether treatment (9). The subsequent reversal of this trend is of interest as it suggests that the virus may have been dissociated from inhibitors present in the OP fluid as has been observed with FMD virus (10). This advantage is shortlived, however, as a day or two later, the IBR virus was no longer recoverable even after TTE treatment of the OP fluid samples. Apparently, although a chronic form of infection has been described (11) for this agent, it is not the same as the carrier state reported for foot-and-mouth disease virus (2).

The steroid treatment was successful in causing the recrudescence of the IBR virus but few other agents were isolated in spite of determined efforts to do so. In only three instances were cytopathogenic agents other than IBR virus demonstrated in the presence of samples tested. These were not identified but their CPE characteristics were those seen previously with enteroviruses.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the help of Dr. Ralph Grusmark, Mr. James V. Desiderio and the very capable technical assistance of Messers. N. Shuot and W. Parrish.
Table 1. Infectivity titer of Infectious Bovine Rhinotracheitis virus in samples of oesophageal-pharyngeal (OP) fluid from cattle inoculated intranasally or exposed by contact

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<td>3.5</td>
<td>&gt;3.5</td>
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</table>

*I*-inoculated intranasally; C-contact infection
**fresh, untreated sample
***treated with trichlorotrifluoroethane
§plaque forming units, (log$_{10}$) per ml
Table 2. Recovery of Infectious Bovine Rhinotracheitis virus from cattle after steroid treatment or contact with cattle treated with steroid

<table>
<thead>
<tr>
<th>Steer Number</th>
<th>Days after start of steroid treatment*</th>
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<tr>
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<td>0 1 2 3 4 5 6 7 8 9 10 11 14 28</td>
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<td>3</td>
<td>TR**</td>
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<td>13</td>
<td>C</td>
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<tr>
<td>14</td>
<td>C</td>
</tr>
<tr>
<td>15</td>
<td>C</td>
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</table>

* 20 mg dexamethasone (Azium) intramuscularly daily for 10 days.
**TR=steroid treatment; C-untreated contact cattle.
§+cytopathogenic agent recovered from nasal mucus or OP fluid; ⊙=cytopathogenic agent identified as IBR virus by fluorescent antibody test.
INFLUENCE OF IBR VIRUS

REFERENCES

EXPERIMENTAL INFECTION OF WHITE-TAILED DEER WITH *MYCOPLASMA MYCOIDES* VAR *MYCOIDES*

R. J. Yedloutschnig, DVM and A. H. Dardiri, DVM, PhD

INTRODUCTION

Contagious bovine pleuropneumonia (CBPP) is a contagious disease of cattle caused by the organism *Mycoplasma mycoides* var. *mycoides* (*M. mycoides*), and characterized by fibrinous interstitial pneumonia and pleurisy. This disease is presently a serious problem of cattle throughout equatorial Africa with a few sporadic cases reported in South Africa, China, India and Kuwait.¹ The only wild ruminants reported susceptible are water buffalo (*Bubalus bubalus*), African or cape buffalo (*Syncerus caffer*), yak (*Bos grunniens*) and bison (*Bison*).¹⁰¹¹

Sera from 8 East African wildlife species tested by the complement fixation (CF) test demonstrated antibodies in the white-bearded wildebeest (*Connochaetes taurinus*) and hippopotamus (*Hippopotamus amphibius*); antibodies were not demonstrated from the Kenya impala (*Aepyceros melampus*), East African eland (*Taurotragus oryx*), topi (*Damaliscus corrigum*), waterbuck (*Kobus ellipsiprymnus*), African buffalo (*Syncerus caffer*) and zebra (*Equus burchelli*).¹² This same report indicated that wildebeest are not susceptible to *M. mycoides* infection.

Evidence of *M. mycoides* infection has not been reported in the white-tailed deer (*Odocoileus virginianus*). This investigation tested the susceptibility of white-tailed deer to experimental infection with *M. mycoides*.

MATERIALS AND METHODS

Animals

White-tailed deer (*O. virginianus*) were supplied by Dr. Frank Hayes, Director, Southeastern Cooperative Wildlife Study, Athens, Georgia. Three deer were housed together in an isolation room.¹ One deer (#42) was utilized as an uninoculated contact control while 2 others (#21 and #25) were each inoculated with *M. mycoides*. Inoculation routes used were 5 ml intranasally (IN) and 20 ml directly into the trachea with a 1" 20 gauge needle attached to a 20 ml syringe.⁵¹³
An 18 month old grade Hereford steer in a separate isolation room was inoculated simultaneously by endobronchial intubation with 80 ml of the same M. mycoides broth culture utilized for deer inoculation. Four steers in another isolation room were later inoculated endobronchially with a culture of M. mycoides isolated from the lung of an infected deer at necropsy.

**Mycoplasma for Animal Inoculation**

The virulent gladysdale strain of M. mycoides was used in this study for inoculation of deer and a steer. It was maintained as a frozen viable seed culture (−70°C) and routinely produces lung lesions in cattle by endobronchial intubation method.²

**Culture Methods**

Brain heart infusion broth (Difco) containing 20% horse serum (BHIH) with thallium acetate and penicillin as bacterial inhibitors was used for growing M. mycoides organisms.⁸ Cultures were incubated 3 to 4 days until the medium became turbid. Viable cells were counted by simple decimal dilution methods.⁷

**Mycoplasma Isolation Attempts**

One ml of whole blood taken from each deer and the inoculated steer at 5 and 10 days post inoculation (DPI) were added to 9 ml of BHIH medium, and tenfold dilutions were made in BHIH to determine the titer of mycoplasma in the blood (mycoplasmaemia). Following 4 days incubation at 37°C each sample was streaked on BHIH agar plates (2% agar), incubated and observed 7 days for identification of typical mycoplasma morphology.

A 10% suspension of lung, bronchial lymph node, spleen and heart blood from the necropsied deer were prepared in BHIH and titrated similarly to the whole blood samples above.

**Serological Tests**

Two serological antigens were prepared: 1) for M. mycoides and 2) for the mycoplasma isolated from the lung of the necropsied deer. Both were grown in 1 liter batches of BHIH broth, incubated 7 days, then centrifuged at 48000 X G for 120 minutes in the Sorval RC-2B centrifuge. The sedimented cells (pellet) were then resuspended in saline containing 1:10000 thiomersol and recentrifuged at 48000 X G for 60 minutes; a process which was repeated twice. The final pellets were resuspended in saline to 1/100 of the original volume and used as complement fixing antigen.³ The CF test method was similar to that of the Laboratory Branch Task Force⁹ utilizing the micro technique with an 18 hour fixation time. This CF test was used to detect antibodies to M. mycoides from sera of cattle and deer at 0 and 10 DPI. The 2 serological antigens
were identified by means of the CF test using hyperimmune anti-
serum to *M. mycoides* prepared in rabbit.\textsuperscript{11}

RESULTS

The *M. mycoides* culture used for inoculation of the 2 deer and a
steer contained $10^7$ viable organisms per ml. One of the inoculated
deer (#25) and the inoculated steer showed a thermal response
3 to 4 DPI which peaked at about $106^\circ$F and continued above normal
until the deer died at 24 DPI or the steer was euthanized at 21 DPI.
Neither the other inoculated deer (#21) nor the uninoculated deer
(#42) developed a thermal response.

The only clinical signs observed were slight depression and
lethargy of one inoculated deer which was found dead at 24 DPI in a
pool of blood exuding from both the oral and nasal cavities. Necropsy
revealed gross lesions confined to the respiratory system. The trachea
was completely blocked with clotted blood throughout its entire length
and extending into the bronchus of the left lung where ruptured blood
vessels caused massive hemorrhage. This side, however, contained
the only functional lung tissue remaining since the entire right lung
was consolidated and filled with tiny, whitish, (1 X 1 mm pustules).
No adhesions, excessive fluid or fibrin were seen. All thoracic
lymph nodes were enlarged.

Following euthanasia the necropsied steer demonstrated typical
lesions consistent with those seen in CBPP.\textsuperscript{7}

*Mycoplasma* Isolation

Mycoplasmaemia was detected in the steer at 5 DPI only and at 5
and 10 DPI from deer #25. Mycoplasma were cultured from the lung
lesion, bronchial lymph nodes, spleen, and heart blood clot from an
inoculated deer and from lung lesions material from the steer and
had an average titer of $10^4$ organisms per gram of tissue. The myco-
plasma isolated from the deer lung was passaged in BHIH, contained
$10^6$ viable organisms per ml, and produced typical signs and lesions
of CBPP in the inoculated steer.

*Complement Fixation Test*

The antigen prepared from the mycoplasma isolated from the lung
of the inoculated deer was positive against *M. mycoides* rabbit anti-
serum at a CF titer of 600. The 10 DPI serum samples from both
inoculated deer (#25 and #42) and the steer showed a rise of CF
antibody compared to the pre-inoculation serum; CF antibodies were
not detected in serum from the uninoculated deer (table 1); the titers
were not subsequently checked.
INFECTION OF WHITE-TAILED DEER

DISCUSSION

Results in this study showed for the first time that the white-tailed deer are susceptible to *M. mycoides* by clinical, serological and pathological evidence. Lesions of marbling, fibrinous adhesions, excessive pleural fluid or sequestra normally observed in cattle affected with CBPP were not seen at necropsy of the deer. The massive hemorrhage of pulmonary vessels producing blockage of the air passage-way was related to the extensive pneumonia involving the right lung. The combination of hyperexcitability of the deer and long course of infection possibly overstressed the respiratory system producing a breakdown of the pulmonary blood vascular system in the remaining functional lung.

Another deer similarly inoculated with identical cultures of *M. mycoides* failed to show clinical signs of illness or mycoplasmaemia. This result is not unusual in pathogenicity studies of *M. mycoides* in cattle where a great variation in susceptibility of individual animals, even of those never exposed to infection occurs. A rise in the serum CF antibody does indicate an active infection. Although this deer was not necropsied, not all *M. mycoides* infected cattle that are serologically CF positive, show signs of illness or visible lung lesions at necropsy.

Although a limited number of deer were used in this experiment, the success of establishing experimental infection of CBPP in deer raised the question of its role as a transmitter of the disease either to other deer or bovine. Shifrine comments that the role of wildlife in dissemination of CBPP is unknown, but a reservoir of a disease within a wild bovid population could present a big obstacle to its control and eradication in domestic bovids.

Two deer inoculated intratracheally with *M. mycoides* responded with low titer complement fixing antibodies and 1 deer died. *M. mycoides* in pure culture was isolated from lung, bronchial lymph node, spleen and heart blood clot from the necropsied deer. A viable culture of *M. mycoides* from the deer lung inoculated by endobronchial intubation into 4 steers produced typical clinical signs and pathological lesions of CBPP. A third uninoculated contact control deer failed to develop mycoplasmaemia, clinical signs or serological response through 14 days post contact.

ACKNOWLEDGMENT

The authors wish to thank Mr. Peter Mikiciuk for his technical assistance.
Table 1

COMPLEMENT FIXATION TITERS* OF DEER AND BOVINE SERA FOLLOWING EXPOSURE TO MYCOPLASMA MYCOIDES VAR. MYCOIDES

<table>
<thead>
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<th>Days Post Exposure</th>
<th>Deer Identification</th>
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<td>10</td>
<td>16</td>
<td>32</td>
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\(^a\) Intratracheal & intranasal inoculation

\(^b\) Uninoculated contact control

\(^c\) Endobronchial-intubation

\(^*\) Reciprocal of serum dilution producing 50% fixation
REFERENCES

REPORT OF THE COMMITTEE ON
FOREIGN ANIMAL DISEASE

Chairman: Brigadier General Thomas G. Murnane, Washington, DC
Co-Chairman: C. J. Maré, Tucson, AZ


The committee on Foreign Animal Diseases met on November 10 and 11, 1976 during the annual meeting of the USAHA held in Bal Harbor, Florida. Fifteen committee members attended the meetings.

The Committee was pleased to report the publication of the handbook, Foreign Animal Diseases, Their Diagnosis, Prevention and Control. This is the third edition of the publication and continues one of the fundamental objectives and charges of the Committee. This edition of Foreign Animal Diseases presents current concepts and the Federal/State organization for emergency animal disease eradication. The etiology, clinical signs, pathologic changes, diagnosis, epizootiology, control and eradication and public health aspects of thirty-one exotic diseases of food and work animals are discussed. The Committee Chairman will solicit the aid of the many authors who contributed to the present edition in reporting annually on the incidence of the diseases and new developments of interest. The Committee Chairman wishes to express his appreciation to the many contributors and officials of the USAHA who made the publication possible.

INTERNATIONAL PROGRAMS

Pan American Highway

Foot-and-Mouth Disease (FMD) does not exist on the North American continent, and efforts have thus far been successful in preventing the movement of this disease from Colombia into Panama, Central America, Mexico, and the United States. As reported previously to this committee, the completion of the Pan American Highway between Panama and Colombia would provide a convenient means of ground communication through an area that has previously been an effective barrier against the movement of animals and, consequently, the spread of FMD. As a result, USDA cooperative programs have been entered into with Panama and Colombia aimed at providing protection against the northward spread of FMD.

The United States National Security Council has recommended
that no further bids for highway construction be let until the USDA has determined that effective FMD surveillance and control programs have been established with Panama and Colombia. An additional delay to highway construction was experienced when a temporary injunction was placed into effect enjoining the Federal Highway Administration (FHWA) of the U. S. Department of Transportation (DOT) from entering into any contract, obligating or expending any funds, or taking any other action whatsoever in furtherance of the Darien Gap Highway until the FHWA and DOT prepared an environmental impact statement which would comply fully with the requirements of the National Environmental Policy Act of 1969. One of the major elements included in the statement was the impact that FMD would have upon the United States should the FMD surveillance and control programs in Panama and Colombia be unsuccessful in preventing FMD from moving northward.

The program in Panama has made good progress and appears to be running smoothly. However, as was reported to this association last year, the USDA cooperative program with animal disease control authorities in Colombia has, thus far, failed to accomplish all of the objectives agreed upon by the two countries. The administrative difficulties in Colombia, reported to you previously, continue to slow purchases of equipment, building of control posts, movement of cattle herds located near the area borders, and similar activities. The program is still moving very slowly, and again, we must state that unless it is speeded up, it will not provide the FMD protection necessary.

SCREWWORM (SW) PROGRAM STATUS

During calendar year 1976 (January 1-October 2, 1976) there were 20,514 confirmed SW cases in the continental United States: Texas—20,258; New Mexico—64; Arizona—137; California—9; Oklahoma—53; and Arkansas—2. There were 11,394 SW cases reported in Mexico within the barrier zone and 12,564 SW cases south of this barrier. During this period, the Mission, Texas, plant produced nearly 10 billion sterile SW flies with more than 5 billion distributed in the United States and more than 4 billion distributed in northern Mexico.

A new strain of fly was introduced into production in mid-March 1976. According to a battery of tests and performance evaluations, this strain of fly proved to be larger and superior to previous strains produced. With this strain of sterile fly, the program was successful in keeping infestations in New Mexico, Arizona, and California to a minimum. However, due to weather conditions favorable to the native fly population a large number of cases occurred in Texas.

Other factors that contribute to the large numbers of the wild SW flies were the 100 percent increase in cattle populations in south
Texas, an even greater increase in the deer population and a change in livestock management practices. There is evidence, however, suggesting that the new strain of sterile fly had a beneficial effect in holding down the number of screwworm cases.

The three-host Gulf Coast Tick infests a large number of hosts and is extending into south, central and east Texas and as far north as Oklahoma. About 90 percent of the SW cases are found in ear wounds caused by the ticks during July, August and September when tick infestations are greatest. Field test using Rabon® or Dursban® insecticide-impregnated ear tags or ear bands greatly reduced tick infestations of test cattle, and no SW were found in the ears of treated test cattle. Whether this method of control will be sufficiently available and utilized widely enough by cattlemen remains to be seen.

After considerable study and evaluation, the U.S. Department of Agriculture concluded that the SW Eradication Data System, as developed by the National Aeronautics and Space Administration, was not sufficiently useful to be incorporated into the eradication program.

Effective August 3, 1976, Federal Regulations (CFR, Part 83, Title 9) were amended to designate the remainder of the State of Texas as an area of recurring SW infestation.

The most encouraging development in the SW program is the completion of the Joint U. S.-Mexico SW sterile production plant in southern Mexico at Tuxtla Gutierrez.

The immediate goal of the SW program is to eradicate screwworms from Baja California and northern Mexico. Sterile flies from the Tuxtla Gutierrez and the Mission, Texas, plants will be used to free northern Mexico of SW infestation and therefore reduce the present 2,000 mile SW barrier between the two countries to a 125 mile barrier zone across the Isthmus of Tehuantepec in southern Mexico. The new barrier zone will cost an estimated $1.8 million annually, and will eliminate SW losses in the United States and most of Mexico.

General distribution of sterile flies from the Tuxtla plant began the week ending September 4, when 2½ million sterile flies were airlifted to Baja California and distributed there.

WORLD ANIMAL DISEASE SITUATION

Rinderpest

While the widespread use of rinderpest vaccine in Africa and Asia resulted in a marked decrease in the incidence of the disease, rinderpest continues to be a major threat to the cattle populations of those continents.

In Asia, the disease remains sporadic in the Middle East where
vaccine is widely used. In India the disease incidence has shown a marked decline from over 1,000 cases in 1973 to 126 cases in 1975.

The JP-15 rinderpest vaccination campaign has continued to be successful, and the incidence of the disease is now very low. Recent political upheavals in parts of Africa, however, have resulted in a breakdown of control procedures, with a resultant increase in sporadic outbreaks of the disease. The continued application of vaccination and other control measures should result in the eventual elimination of rinderpest as a major threat to the cattle industry.

Contagious Bovine Pleuropneumonia (CBPP)

CBPP, for many years an important endemic disease in Australia, was officially declared eradicated from that country in 1973, the last case of the disease having occurred in 1967.

In Africa the disease persists as a serious problem, and progress toward control of the disease is slow. Outbreaks of CBPP occurred in South Africa in 1975, 51 years after the disease was eradicated from that country. The disease has occasionally spread from the African continent into the Middle East where outbreaks have occurred in several countries where vaccination is not practiced. The disease is still endemic in India. Egypt was declared free of the disease in 1976.

The most recently infected countries in Europe, namely France and Spain, have been free of the disease since 1967. Vaccination against CBPP is currently practiced in at least 20 African countries.

African Horse Sickness (AHS)

AHS was formerly considered to be limited to East and South Africa, but during 1959, the Near East experienced a panzootic that resulted in the loss of many hundreds of thousands of horses. Since this epizootic, however, no other cases have been observed in the Near East. There also have been no further cases in Spain since 1966. The only reports of the disease in the last 6 months have been from Africa. Outbreaks of African horse sickness occurred in Kenya in September 1975, and a limited outbreak occurred in Chad, the first since 1961. This disease occurs sporadically in Malawi and still occurs in the Republic of South Africa. Cases have also been reported in the Sudan and Swaziland in 1976.

African Swine Fever (ASF)

ASF continues to occur in Spain (221 cases in 1974 and 516 in 1975) and Portugal (126 outbreaks in 1974 and 468 in 1975). Due to eradication procedures, but mostly due to the management practice of confinement and double fencing, ASF is no longer a threat in

**Foot-and-Mouth Disease (FMD)**

FMD is the major barrier to international commerce in animals and meat and affects a great part of the world. With the exception of the North American Continent, only Australia and New Zealand of the major livestock-producing countries are considered to be free of this disease.

In general, the FMD situation in Europe remained favorable throughout 1975 and 1976. In France, only one limited FMD outbreak occurred due to the accidental introduction of virus in January 1975. Small outbreaks also occurred in Holland, West Germany, Austria, Czechoslovakia, Spain, and Tunisia. East Germany, previously free since July 1971, experienced an outbreak of type C in pigs in April of 1976. Seven premises were involved and the virus appeared to be quite virulent. It extended into Italy and affected sheep, swine, and cattle even though vaccinated. Malta was infected with type O virus in June of 1975 for the first time in 29 years.

An impact of foot-and-mouth disease frequently overlooked is the loss of agricultural power in countries using cloven hoofed animals as the primary source of agricultural motive power. The presence of foot-and-mouth disease in these animals results in production losses which far exceed the direct loss of meat and milk.

**FOREIGN ANIMAL DISEASE SURVEILLANCE AND TRAINING**

During fiscal year 1976 (1 July '75-30 June '76) foreign animal disease surveillance activities resulted in 76 investigations. All were negative for foot-and-mouth disease and other exotic diseases. During the transition quarter, (1 July '76-30 September 1977) 23 investigations were conducted. One horse at Prescott, Arizona was serologically positive for N. J. vesicular stomatitis on both acute and convalescent samples indicating a previous infection.

The production of 10 foreign animal disease films by the Emergency Programs, APHIS and the Plum Island Animal Disease Center was continued. One film was completed and distributed, and footage was made for nine additional films. These films are directed primarily toward professional audiences but will be useful in increasing public awareness of foreign animal diseases. In addition, four Foreign Animal Diseases Awareness Seminars were held at four colleges of veterinary medicine. Three Foreign Animal Diseases Training Courses were conducted with 43 veterinarians receiving training.

In late 1971, the newly organized Emergency Programs of Veterinary Services, APHIS, USDA, was charged with the responsibility
of developing plans for dealing with some 40 animal diseases which pose an economic threat to the United States livestock and poultry industries. A literature retrieval system is a necessary component for an effective disease control program and after careful study a combination system employing microfilm with a special coding system and a computer bank of coded information was adopted.

Currently, there are over 13,000 articles covering 10 diseases in the system. These include articles on foot-and-mouth disease, hog cholera, trypanosomiasis, Venezuelan equine encephalitis, vesicular exanthema of swine, African swine fever, swine vesicular disease, and Newcastle disease. All articles in the system are in the English language. Articles in other languages are translated before they are added to the system.

NEW DEVELOPMENTS IN VESICULAR DISEASES

A significant increase in the use of oil adjuvanted foot-and-mouth disease vaccines has occurred over the last three years. This type of vaccine, developed by U. S. technology, can be used to successfully immunize pigs which was not possible with previous formulations. These new vaccines are being used in Spain at the level of 9 million doses per year. An extensive trial of a similar vaccine is being done in 100 thousand cattle in Brazil. In addition to protecting swine these vaccines should reduce the frequency of vaccinations required to sustain immunity in cattle.
METHODS FOR BIOLOGIC PREPARATION, ISOLATION, IDENTIFICATION AND CHARACTERIZATION OF AVIAN INFLUENZA A VIRUSES

W. K. Butterfield, PhD

INTRODUCTION

Fowl plague has been considered the only exotic disease of any consequence caused by avian influenza A viruses. However, in addition to fowl plague, avian influenza A viruses have produced other highly virulent disease. The turkey industry in the United States has suffered heavy losses over the past decade as a result of avian influenza A virus infections. Disease outbreaks in three laying chicken flocks in Alabama in 1975 resulted in over 50% mortality. This was the first time since 1929 that an influenza infection was observed in chickens in the U.S.

This report will describe new and accepted methods for the production of biologics; review techniques used to differentiate subtypes of avian influenza A viruses; and point out the importance of identification and characterization of virus isolates.

MATERIALS AND METHODS

A. Virus production:

Influenza A viruses with nine avian hemagglutinin subtypes (HAv_{1-9}), six avian neuraminidase subtypes (Nav_{1-6}), two equine subtypes (Neq_{1-2}), and a human neuraminidase subtype (N_{a}) were obtained from the Plum Island Animal Disease Center (PIADC) virus repository or through the courtesy of Dr. R. G. Webster, St. Jude Children's Hospital, Memphis, Tennessee, and Dr. G. C. Schild, WHO World Influenza Center, Mill Hill, London, England. The viruses listed in Table 1 represent available subtypes that have the reported hemagglutinin and neuraminidase surface antigens.

The viruses were passaged by inoculation into the chorioallantoic sac (CAS) of 10 to 11-day-old embryonating chicken eggs, and the combined amniotic and allantoic fluids (AAF) were harvested 48-72 hours postinoculation. The AAF was clarified by centrifugation at 1500 rpm for 20 minutes. Stock viruses were stored at -70°C. Virus was concentrated by pelleting and purified by double density gradient centrifugation through sucrose. Purified virus was inactivated for 24 hours at 37°C with formalin at a final concentration of 1/2000. Innocuity tests were done by inoculation of 10 embryonating chicken
eggs via the CAS with 0.1 ml of inactivated virus per egg and by testing harvested AAF for hemagglutination of chicken red blood cells before inoculation of guinea pigs for antiserum production.

B. Antiserum production and testing:

Antiserums were produced with influenza A viruses as previously described and then tested against homologous virus and representative viruses possessing each of the heterologous hemagglutinin and neuraminidase surface antigens. Three tests were performed: neutralization tests in embryonating chicken eggs, in which constant serum and variable virus dilutions were used; hemagglutination-inhibition (HAI) tests in microtiter plates; and neuraminidase-inhibition (NI) tests as described by Webster and Campbell.

C. Isolation and characterization of avian influenza A viruses:

Influenza A viruses were isolated by inoculation of 9 to 11-day-old embryonating chicken eggs via the CAS with suspensions of tracheal or cloacal swab material taken from live birds or tissue homogenates of lung, tracheal mucosa, and blood from dead birds. Egg incubation temperatures of 33-36°C are optimal for virus isolation. AAF is harvested 48-72 hours postinoculation and clarified as described under “Virus production”. Two or three blind passages in embryonating chicken eggs may be required, but generally, hemagglutinin and neuraminidase may be detected after one passage of avian influenza A viruses. AAF was spot tested to detect hemagglutinin by mixing one drop of chilled AAF with one drop of 5% chicken red blood cells (diluted in PBS, pH 7.2) and allowing cells to settle. Uninoculated AAF is treated in the same manner to serve as a control. AAF is then clarified by centrifugation at 1500 rpm for 20 minutes. Clarified AAF is used for the determination of influenza virus type with an agar gel immunodiffusion test against anti-influenza ribonucleoprotein serum. This test may be read within 24 hours.

The virus isolates are subtyped with antiserum against the known hemagglutinin and neuraminidase subtypes in HAI and NI tests.

Chickens, turkeys, ducks, and other available avian species should be inoculated intratracheally and intranasally with original isolation material, with and without antibiotics, for determination of virulence. Birds should be observed for clinical signs, and antibody development should be determined by testing 21-day serum against the homologous virus and all prototype viruses in HAI and NI tests.

RESULTS

All viruses used for serum production were inactivated by formalin as determined by innocuity tests in embryonating chicken eggs.
Results of virus neutralization are shown in Table 2. Cross reactions were observed between antiserums and viruses with the same hemagglutinin subtypes and in one instance between viruses and antiserum with the same neuraminidase subtype.

Hemagglutination-inhibition tests were highly specific as shown in Table 3. Only viruses with the same hemagglutinin subtype and the respective antiserums showed HI reactions at a dilution of 1:20 or higher.

Strong heterologous reactions were observed only in NI tests although whole virus antigens were used in antiserum production. Heterologous cross reactions were observed in NI tests because the hemagglutinin probably caused steric inhibition of the neuraminidase reactions as shown in Table 4. In all tests, the reaction was stronger with the homologous system. Heterologous cross NI reactions were observed with viruses and antiserums to homologous hemagglutinin (Hav1) or neuraminidase (Neq2).

DISCUSSION

The battery of avian influenza A viruses and antiserums were produced to update diagnostic kits produced by the Food and Agriculture Organization of the United Nations that did not contain all reported virus prototypes and antiserums. The antiserums were produced in guinea pigs to eliminate problems encountered with avian serums.

When the described biologic production, virus isolation and characterization procedures are followed, the diagnostician can identify the subtype of influenza A virus isolated or determine whether he has in fact, isolated a new subtype. A new subtype may be confirmed by back testing the 21-day avian serum against the known antigens and homologous virus in HAI and NI tests. Problems encountered with cross reactions in the NI test may be alleviated by the production of mono-specific antiserums prepared against specific neuraminidase after separation from hemagglutinin or by the use of recombinant viruses.

Important criteria of influenza virus characterization are pathogenicity challenges of avian species. Field personnel should take specimens of several grams or several swabs so that the diagnostician may have large enough samples to challenge birds with original isolation material with and without the use of antibiotics. AAF submitted to PIADC for virus identification caused chickens to develop specific antibody to the homologous virus. However, clinical disease signs were not produced in the chickens although mortality rates in
Characterization of influenza A viruses shows that fowl plague viruses (either Hav_{Neq}, or Hav_{N_1}) are not the only influenza A viruses that should be classified as exotic disease agents. Many other subtypes produce disease signs with high morbidity and mortality in a variety of avian species. Influenza A/tern/South Africa/61 (Hav_{Nav_2}), A/chicken/Scotland/59 (Hav_{N_1}), and A/turkey/England/63 (Hav_{Nav_2}) are just a few of the viruses other than classical fowl plague that are highly pathogenic for poultry. The term fowl plague-like disease is misleading and its use should be discontinued. Many avian influenza A viruses other than the classical fowl plague viruses produce disease manifestations with high morbidity and mortality. The World Health Organization Expert Committee on Influenza has recommended that influenza viruses be placed into type A, B, or C and that viruses be designated by a uniform code system such as influenza A/duck/Ukraine/1/63 where “A” refers to type, “duck” to species of origin, “Ukraine” to the place of origin, “1” to the strain serial number, and “63” to the year of isolation.

A second significant reason for characterizing influenza isolates is that once the virus is subtyped, vaccines may be produced with avirulent viruses or with recombinant viruses possessing the same hemagglutinin or neuraminidase surface antigens.

As feral birds and imported avian species are screened for Newcastle disease virus, additional influenza virus subtypes will probably be isolated. Avian species may be imported into the U.S. if viruses isolated from them fail to produce disease signs when tested for pathogenicity in the diagnostic laboratory. In light of the facts that fowl plague was introduced into Australian poultry in January 1976, that the pathogenicity of concurrent infections of influenza A viruses with other microorganisms is unknown, and that many influenza viruses are limited as to avian species affected, perhaps stronger legislation should be enacted to allow regulatory officials to deny entry to the U.S. of avian shipments from which any hemagglutinating virus is isolated be it viscerotropic velogenic Newcastle disease virus, influenza, or other paramyxoviruses.

ACKNOWLEDGMENTS

I would like to thank Mr. E. V. Kramer, Jr., for technical assistance, Messrs. S. J. Moisa and N. Stilley for animal care, and Mrs. Clara Begley for manuscript preparation.
Table 1. Hemagglutinin and neuraminidase subtypes of avian influenza viruses used for antiserum production

<table>
<thead>
<tr>
<th>Virus</th>
<th>Hemagglutinin subtype&lt;sup&gt;A&lt;/sup&gt;</th>
<th>Neuraminidase subtype&lt;sup&gt;A&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/turkey/England/63</td>
<td>av&lt;sub&gt;1&lt;/sub&gt;</td>
<td>av&lt;sub&gt;3&lt;/sub&gt;</td>
</tr>
<tr>
<td>A/quail/Italy/1117/65</td>
<td>av&lt;sub&gt;2&lt;/sub&gt;</td>
<td>eq&lt;sub&gt;2&lt;/sub&gt;</td>
</tr>
<tr>
<td>A/duck/England/56</td>
<td>av&lt;sub&gt;3&lt;/sub&gt;</td>
<td>av&lt;sub&gt;1&lt;/sub&gt;</td>
</tr>
<tr>
<td>A/duck/Czech/56</td>
<td>av&lt;sub&gt;4&lt;/sub&gt;</td>
<td>av&lt;sub&gt;1&lt;/sub&gt;</td>
</tr>
<tr>
<td>A/tern/South Africa/61</td>
<td>av&lt;sub&gt;5&lt;/sub&gt;</td>
<td>av&lt;sub&gt;2&lt;/sub&gt;</td>
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<tr>
<td>A/shearwater/E. Australia/37/72</td>
<td>av&lt;sub&gt;6&lt;/sub&gt;</td>
<td>av&lt;sub&gt;5&lt;/sub&gt;</td>
</tr>
<tr>
<td>A/duck/Ukraine/1/63</td>
<td>av&lt;sub&gt;7&lt;/sub&gt;</td>
<td>eq&lt;sub&gt;2&lt;/sub&gt;</td>
</tr>
<tr>
<td>A/turkey/Ontario/6118/68</td>
<td>av&lt;sub&gt;8&lt;/sub&gt;</td>
<td>av&lt;sub&gt;4&lt;/sub&gt;</td>
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<td>A/turkey/Wis/66&lt;sub&gt;H&lt;/sub&gt;-N&lt;sub&gt;1&lt;/sub&gt;&lt;sup&gt;B&lt;/sup&gt;</td>
<td>av&lt;sub&gt;9&lt;/sub&gt;</td>
<td>N&lt;sub&gt;1&lt;/sub&gt;</td>
</tr>
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<td>eq&lt;sub&gt;1&lt;/sub&gt;</td>
</tr>
<tr>
<td>A/FPV/Rostock/34</td>
<td>av&lt;sub&gt;1&lt;/sub&gt;</td>
<td>N&lt;sub&gt;1&lt;/sub&gt;</td>
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<tr>
<td>A/duck/Memphis/546/74</td>
<td>av&lt;sub&gt;3&lt;/sub&gt;</td>
<td>av&lt;sub&gt;6&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

<sup>A</sup> av = avian; eq = equine; and N = human

<sup>B</sup> recombinant virus provided by Dr. R.G. Webster, St. Jude Children's Research Hospital, Memphis, Tennessee. 9
Table 2. Cross neutralization test results with avian influenza A viruses and antiserums

<table>
<thead>
<tr>
<th>Antiserum</th>
<th>Virus subtype A, B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>2-Neq₂ 3-1 4-1 5-2 6-5 7-Neq₂ 8-4 9-N₁ 1-Neq₁ 1-N₁ 3-6</td>
</tr>
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<td>6-5</td>
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<td>7-Neq₂</td>
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<td>1-N₁</td>
<td>&gt;6.0</td>
</tr>
<tr>
<td>3-6</td>
<td>6.5</td>
</tr>
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</table>

A = Avian subtypes unless indicated Neq (equine) or N (human); first number indicates hemagglutinin subtype and second number indicates neuraminidase subtype.

B = Numbers in field of table indicate titer in log₁₀. Blanks indicate reactions of log₁₀ 1.0 or less.
Table 3. Cross hemagglutination inhibition test results with influenza A viruses and antiserums

<table>
<thead>
<tr>
<th>Antiserum</th>
<th>1-3</th>
<th>2-Neq₂</th>
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<th>5-2</th>
<th>6-5</th>
<th>7-Neq₂</th>
<th>8-4</th>
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<td>1280</td>
</tr>
</tbody>
</table>

A = Avian subtypes unless indicated Neq (equine) or N (human); first number indicates hemagglutinin subtype and second number indicates neuraminidase subtype.

B = Numbers in field of table indicate antiserum dilution inhibiting four hemagglutinating units of virus. Blanks indicate reactions of 10 or less.
Table 4. Cross neuraminidase inhibition test results with influenza A viruses and antiserums

<table>
<thead>
<tr>
<th>Antiserums</th>
<th>Virus subtype A,B</th>
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<td></td>
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<td>1-3</td>
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<td></td>
</tr>
<tr>
<td>8-4</td>
<td></td>
</tr>
<tr>
<td>9-N₁</td>
<td></td>
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<tr>
<td>1-N₁</td>
<td>1.73</td>
</tr>
<tr>
<td>3-6</td>
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</table>

A = Avian subtypes unless indicated Heq (equine) or N (human); first number indicates hemagglutinin subtype and second number indicates neuraminidase subtype.

B = Numbers in field of table indicate dilution in $\log_{10}$ inhibiting 50% neuraminidase activity. Blanks indicate reactions of $\log_{10}0.5$ or less.
REFERENCES


IMMUNOSUPPRESSIVE EFFECTS OF THE INFECTIOUS BURSAL AGENT AND RELATIONSHIPS TO OTHER POULTRY DISEASES

J. K. Rosenberger, PhD and J. Gelb, MS

SUMMARY

After inoculation with the infectious bursal agent (IBA) at one day of age, specific pathogen-free chickens were inoculated with either Newcastle disease virus (NDV), infectious bronchitis virus (IBV) or infectious laryngotracheitis virus (ILTV). Their immunity was then challenged two to three weeks later with homologous virus and antibody titers were determined.

In addition, several studies were conducted to determine the effects of the infectious bursal agent on the development of persistent or chronic infections with the aforementioned respiratory viruses. Infectious bursal agent susceptible chickens were exposed to the IBA at one day and subsequently inoculated at two weeks of age with either NDV, IBV or ILTV. At two, three, four and five weeks postinoculation with the respiratory viruses, tracheal swabbings were collected for virus isolations. The birds were challenged with homologous virus at five weeks postinoculation.

Results from these experiments have shown that early (1 day) infections with the IBA have an affect on the response of young birds to several avian respiratory viruses.

This was demonstrated by decreased resistance to challenge and lowered humoral antibody levels for birds inoculated with ILTV and NDV. Birds infected with IBV and the IBA withstood IBV challenge but were much more prone to persistent infections than were the non-IBA exposed birds. High mortality rates and decreased weights in all IBA inoculated groups demonstrated the damaging effects of early IBA exposure.

INTRODUCTION

The bursa of Fabricius in the chicken is a lymphoepithelial structure located dorsal to the cloaca. In 1962, Cosgrove (1) described a virus induced disease of chickens which affected the bursa of Fabricius. Bursae from infected chickens are characterized by a severe depletion of the lymphoid elements of the medulla, pronounced proliferation of the connective tissue stroma and hypertrophy of the bursal epithelium.

The virus, the infectious bursal agent, has also been found to
cause a general lymphocidal effect in the spleen, cecal tonsils and thymus. However, the primary target organ, based on virus replication studies appears to be the bursa of Fabricius.

Hitchner (3) demonstrated that parental antibody to the IBA could prevent degeneration of the bursa of Fabricius in chickens exposed to the IBA as late as three weeks of age. These results were supported by findings (5) that chickens from IBA immune parents were resistant to infection with the IBA when inoculated at one day of age. These factors are important in understanding the chicken's resistance or susceptibility to various infectious diseases since several workers (2,4,6) have demonstrated that atrophy of the bursa of Fabricius induced by early exposure (one day of age) to the IBA depresses the birds ability to produce humoral antibody and to resist infectious disease.

The purpose of this study was to investigate the effects of exposure to the IBA at one day of age on the response to several respiratory disease vaccines in chickens derived from IBA immune and nonimmune parents.

MATERIALS AND METHODS

After exposure to the IBA at 1 day of age, specific pathogen-free single comb White Leghorn chickens were vaccinated at 2 weeks of age with either Newcastle disease virus (NDV), infectious bronchitis virus (IBV) or infectious laryngotracheitis virus (ILTV). Two to three weeks later they were challenged with homologous virus and their antibody titers determined.

In addition, several studies were conducted to determine the effects of the IBA on the development of persistent or chronic infections with the previously mentioned respiratory viruses. Infectious bursal agent susceptible chickens were exposed to the IBA at 1 day and subsequently inoculated at 2 weeks of age with either NDV, IBV or ILTV. At 2, 3, 4, and 5 weeks postinoculation with the respiratory viruses, tracheal swabbings were collected for virus isolations. The birds were challenged with homologous virus at 5 weeks postinoculation.

RESULTS

Results as shown in Table 1 indicates the IBA does have an effect on the immune response to NDV in IBA nonimmune chicks. This was reflected by a decrease in NDV antibody titers as well as responses to challenge with velogenic NDV. Birds with IBA parental antibody were unaffected by the IBA. A similar response was observed with the ILTV vaccinated birds (Table 2). Infectious laryngotracheitis virus vaccinated, IBA inoculated chicks from IBA
nonimmune parents were more susceptible to challenge than were immune chicks. No difference, however, could be demonstrated as a result of exposure to the IBA when birds were vaccinated with IBV (Table 3). This was based on results obtained from challenge with homologous virus and subsequent isolation attempts.

Birds infected with IBA and IBV were more prone to persistent IBV infections (Table 4) than were non-IBA exposed birds. Infectious bronchitis virus could be isolated from tracheal swabbings in IBA inoculated birds up to 5 weeks postinoculation while being isolated from non-IBA infected birds only through the second week postinoculation. Increased mortality and decreased weight gains were observed in all of the IBA infected groups. Early infections with the IBA appeared to have little affect on the development of chronic infections with ILTV or NDV (Table 4).

DISCUSSION

The results of this study and others (2,4,6) have established the IBA as an effective immunosuppressive agent in young chickens. Because of the potential for decreasing the efficacy of standard vaccination procedures as well as increasing the susceptibility of chickens to infectious disease, consideration should be given to effective means of controlling the IBA, particularly in young birds (1 day to 2 weeks).

There are at present two methods of preventing IBA induced damage to the immune system of young chickens which can be used commercially. Progeny can be protected by vaccinating the parent stock with the IBA (providing passive protection) or by immunization of the young birds themselves with a nonpathogenic isolant. Eradication of the IBA by most poultry producers is not a realistic alternative at this time.

There are several factors that are associated with current and proposed IBA vaccination procedures that require a continued research effort in order to minimize the undesirable effects of the IBA. The optimum time, route, dose and type of isolant for vaccination of the parent stock have not been determined. Other circumstances (age, nutrition, stage of production, breed, etc.) which may affect levels and duration of maternal antibody being passed to the progeny require investigation. If progeny are to be vaccinated, relatively apathogenic strains of the IBA must be utilized. The ability of these strains to produce an effective immune response should be ascertained.

Continuing projects to better define these questionable areas are presently in progress at the University of Delaware.
Table 1
THE EFFECTS OF EARLY EXPOSURE (1 DAY) TO THE INFECTIOUS BURSAL AGENT (IBA) ON THE IMMUNE RESPONSE OF CHICKENS TO NEWCASTLE DISEASE VIRUS (NDV)

<table>
<thead>
<tr>
<th>Treatment Groups</th>
<th>IBA Serological Status at 35 Days of Age</th>
<th>Mean NDV Antibody Titers</th>
<th>Response to Chall.</th>
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<tr>
<td></td>
<td>(No. Positive/Total)</td>
<td></td>
<td>(No. Affected/Total)</td>
</tr>
<tr>
<td>Noninoculated Controls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) IBA-</td>
<td>0/15</td>
<td>0</td>
<td>Not Challenged</td>
</tr>
<tr>
<td>2) IBA+</td>
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<td>0</td>
<td>Not Challenged</td>
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<tr>
<td>IBA Controls</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3) IBA-</td>
<td>11/11</td>
<td>0</td>
<td>11/11</td>
</tr>
<tr>
<td>4) IBA+</td>
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<td>13/13</td>
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<td>5) IBA-</td>
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<td>6) IBA+</td>
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<td>NDV Challenge Control</td>
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<td>7) IBA-</td>
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<td>13/13</td>
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<td>IBA and NDV</td>
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</tr>
</tbody>
</table>

A = IBA susceptible; birds do not have parental IBA antibody.
B = IBA immune; birds do have parental IBA antibody.

Titers expressed as the reciprocal of the highest dilution which reduced control plaque counts by more than 50%.
Table 2

The Effect of Early Exposure (1 Day) to the Infectious Bursal Agent (IBA) on the Immune Response of Chickens to Infectious Laryngotracheitis Virus (ILTV)

<table>
<thead>
<tr>
<th>Treatment Groups</th>
<th>IBA Serology at 35 Days of Age (No. Positive/Total)</th>
<th>Response to Infraorbital Sinus Challenge (No. Affected/Total)</th>
<th>ILTV Neutralization Indices</th>
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<tr>
<td>Noninoculated Control</td>
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<tr>
<td>1) IBA-</td>
<td>0/15</td>
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<td>Not Done</td>
</tr>
<tr>
<td>2) IBA+</td>
<td>0/15</td>
<td>Not Challenged</td>
<td>Not Done</td>
</tr>
<tr>
<td>IBA Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) IBA-</td>
<td>22/22</td>
<td>22/22</td>
<td>Not Done</td>
</tr>
<tr>
<td>4) IBA+</td>
<td>0/25</td>
<td>25/25</td>
<td>Not Done</td>
</tr>
<tr>
<td>Vaccine Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5) IBA-</td>
<td>0/14</td>
<td>0/14</td>
<td>≥5.0</td>
</tr>
<tr>
<td>6) IBA+</td>
<td>0/15</td>
<td>0/15</td>
<td>≥5.0</td>
</tr>
<tr>
<td>Challenge Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7) IBA-</td>
<td>0/13</td>
<td>13/13</td>
<td>Not Done</td>
</tr>
<tr>
<td>8) IBA+</td>
<td>0/14</td>
<td>14/14</td>
<td>Not Done</td>
</tr>
<tr>
<td>IBA + ILTV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9) IBA-</td>
<td>20/20</td>
<td>4/20</td>
<td>1.9</td>
</tr>
<tr>
<td>10) IBA+</td>
<td>0/22</td>
<td>0/22</td>
<td>-3.0</td>
</tr>
</tbody>
</table>

IAA- = IBA susceptible; birds do not have IBA parental antibody.
IBA+ = IBA immune; birds do have IBA parental antibody.
Table 3
THE EFFECTS OF EARLY EXPOSURE (1 DAY) TO THE INFECTIOUS BURSAL AGENT (IBA) ON THE IMMUNE RESPONSE OF CHICKENS TO INFECTIOUS BRONCHITIS VIRUS (IBV)

<table>
<thead>
<tr>
<th>Treatment Groups</th>
<th>IBA Serological Status at 28 Days of Age</th>
<th>IBV Recovery Five Days Post Challenge</th>
<th>Percent Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(No. Positive/Total)</td>
<td>(No. Isol./Total)</td>
<td></td>
</tr>
<tr>
<td>Noninoculated Controls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) IBA-</td>
<td>10/10</td>
<td>0/10</td>
<td>Not Challenged</td>
</tr>
<tr>
<td>2) IBA+</td>
<td>0/13</td>
<td>0/13</td>
<td>Not Challenged</td>
</tr>
<tr>
<td>IBA Controls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) IBA-</td>
<td>10/11</td>
<td>11/11</td>
<td>0</td>
</tr>
<tr>
<td>4) IBA+</td>
<td>0/14</td>
<td>14/14</td>
<td>0</td>
</tr>
<tr>
<td>IBV Vaccine Controls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5) IBA-</td>
<td>0/12</td>
<td>1/12</td>
<td>92</td>
</tr>
<tr>
<td>6) IBA+</td>
<td>0/14</td>
<td>1/14</td>
<td>93</td>
</tr>
<tr>
<td>IBV Challenge Controls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7) IBA-</td>
<td>0/10</td>
<td>10/10</td>
<td>0</td>
</tr>
<tr>
<td>8) IBA+</td>
<td>0/12</td>
<td>12/12</td>
<td>0</td>
</tr>
<tr>
<td>IBA and IBV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9) IBA-</td>
<td>9/9</td>
<td>1/9</td>
<td>89</td>
</tr>
<tr>
<td>10) IBA+</td>
<td>0/14</td>
<td>1/14</td>
<td>93</td>
</tr>
</tbody>
</table>

*IBA- = Birds do not have parental IBA antibody; IBA susceptible.
IBA+ = Birds do have parental IBA antibody; IBA immune.

Table 4
THE EFFECTS OF EARLY EXPOSURE TO THE INFECTIOUS BURSAL AGENT (IBA) ON A SUBSEQUENT INFECTION WITH INFECTIOUS BRONCHITIS VIRUS (IBV), INFECTIOUS LARYNGOTRACHEITIS VIRUS (ILTV) OR NEWCASTLE DISEASE VIRUS (NDV)

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>Virus Isolations (No. Pos./Total)</th>
<th>Ave. Wt. (Grams)</th>
<th>Mortality (Percent)</th>
<th>Challenge (No.Pos./Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBA + IBV</td>
<td>9/10 4/10 2/10 2/8</td>
<td>563.1</td>
<td>66</td>
<td>0/8</td>
</tr>
<tr>
<td>IBV Alone</td>
<td>2/10 0/10 0/10 0/10</td>
<td>752.2</td>
<td>17</td>
<td>2/23</td>
</tr>
<tr>
<td>IBA + NDV</td>
<td>3/10 0/10 0/10 0/10</td>
<td>635.8</td>
<td>41</td>
<td>1/13</td>
</tr>
<tr>
<td>NDV Alone</td>
<td>0/10 0/10 0/10 0/10</td>
<td>761</td>
<td>14</td>
<td>0/24</td>
</tr>
<tr>
<td>IBA + ILTV</td>
<td>1/10 0/10 0/10</td>
<td>638.6</td>
<td>16</td>
<td>3/24</td>
</tr>
<tr>
<td>ILTV Alone</td>
<td>1/10 0/10 0/10</td>
<td>743.3</td>
<td>3</td>
<td>2/26</td>
</tr>
</tbody>
</table>
REFERENCES


Newcastle Disease

There were no reported cases of velogenic viscerotopic Newcastle disease (VVND) in fiscal year 1976 in the continental United States. The last case occurred in a small mixed poultry flock of 28 chickens in Pharr, Texas, on June 6, 1975. Increased effectiveness of surveillance activities, especially those associated with border inspection and import facilities may have accounted for this period of success. Several isolates have been made from birds which were confiscated along the Mexican border and at import stations in the United States.

VVND still remains a world threat as demonstrated by the fact that at least 10 lots of commercial birds presented for entry in privately-owned quarantine stations were found infected during fiscal year 1976. The national surveillance program for exotic Newcastle disease has enjoyed good lines of communication with poultry and bird industries and practicing veterinarians.

Mycoplasmosis

Veterinary Services filled all official requests for reference antigens for mycoplasma received during fiscal year 1976. There were 181 shipments made to 51 laboratories in 39 states. Veterinary Services is prepared to distribute these reference materials at approximately the same level in fiscal year 1977.

In response to numerous requests for epidemiologic studies of problem flocks encountered through normal mycoplasmal testing procedures and clinical outbreaks in the field two Veterinary Services regional poultry epidemiologists were engaged on projects with the poultry industry.

Flock No. 1. A problem primary breeder flock of Leghorn chickens, with erratic serological responses, but with negative routine cultures was selected for an in-depth cultural study. Reactions were found in
approximately 0.5% of the birds tested with M. gallisepticum antigens.

Five months of cultureing efforts resulted in isolation of a mycoplasma characterized as M. gallisepticum. No clinical disease was noted in the breeder parents of their progeny. The isolate, inoculated into susceptible chicks, resulted in sero-conversion but produced no lesions. The organism was reisolated from the inoculated chickens.

_Flock No. 2._ A turkey flock was selected in the North Central Region, that had lesions of acute airsacculitis at 5 weeks of age and erratic and inconclusive serologic test results was selected for cultural and serologic studies.

A mycoplasma was isolated from the flock and inoculated into susceptible turkeys. The birds were observed regularly with no dramatic signs of mycoplasmosis, however, some swelling and tenderness of the hock joints were observed. On necropsy slight lesions were observed in the abdominal airsacs and a mild pericarditis was present in some of the birds. Cultures of the affected tissues yielded a mycoplasma similar in many characteristics to M. gallisepticum, which was characterized by D. S. H. Kleven of Athens, GA to be compatible to avian mycoplasma serotype I.

Comprehensive virological studies on the chicken and turkey flocks were negative.

Since Mycoplasma meleagridis-free turkey breeder stock will soon be available, the USDA is urged to seek out commercial sources for production or to produce and supply antigen for testing turkey breeder flocks and to continue production of reagents necessary to carry out M. gallisepticum and M. synoviae programs. A need is realized for a national M. meleagridis program sanctioned by the USDA with certification of free status by the states.

A mycoplasma eradication program is jeopardized by introduction of "controlled" vaccination. Goals must be realigned because it is not possible to have clean stock in one section of the poultry industry if another section is to perpetuate infection. A subcommittee was appointed for the study of the mycoplasma problems in close cooperation with a similar committee of the American Assoc. of Avian Pathologists (AAAP).

**Ornithosis**

Veterinary Services assisted in studies in an attempt to determine the pathogenesis and reservoirs for Chlamydia in endemic areas where the agent appears to be more virulent. They initiated the production and distribution of diagnostic reagents to interested turkey growing states for detecting the diseases in turkey flocks.

Between May 6 and June 25, 1974 there were 102 confirmed and
suspected human cases of illness and one death from ornithosis in plant employees and poultry inspectors in 3 states. These infections were attributed to turkey flocks originating in Texas. A cooperative program was initiated in Texas to detect flocks infected before they were presented for slaughter. No additional human cases were reported after the program was initiated.

In April 1975 five cases of ornithosis in turkeys and diagnosis of the illness in a Texas veterinary diagnostician stimulated the re-establishment of a Texas turkey flock program similar to that employed in 1974. The program was believed successful since there were no further human infections or adverse publicity for the industry.

After several months of study in 1975 it became apparent that the indiscriminate use of low levels of chlorotetracycline clouded the clinical disease and made it necessary to perform serological tests and isolation attempts before certifying a flock for slaughter. No human ornithosis was reported in turkey slaughter plant employees since the program began on May 26, 1975.

During 1976 an ornithosis surveillance program in turkey breeder flocks in Texas was voluntary since the likelihood of an ornithosis infected flock was diminished. However a breeder hen flock from a producer in Hico, Texas was processed in a plant in Gibbon, Nebraska on June 15 and 16, 1976. Plant employees became ill beginning June 21 and 22 with symptoms suggestive of ornithosis and disease was confirmed in the breeder flock as well as the plant workers. The ornithosis certification program for Texas turkeys was again emphasized and all breeder turkeys were tested and observed before slaughter.

Prior to the experiences with ornithosis in turkeys in Texas in 1974, ornithosis was considered to be a disease with a cyclical buildup occurring, for the most part, in 7 to 10 year cycles. It appears that ornithosis in commercial turkeys is on the increase and will necessarily require more attention from regulatory and health agencies than it has in the past.

Dr. J. Orsborn reported on a conference on psittacosis held in Los Angeles attended by various facets of the pet bird industry, regulatory and enforcement agencies, private practitioners, state and federal public health officials, and state and university diagnosticians. A report of the in-depth conference is obtainable by writing Dr. J. Orsborn, California State Livestock Diagnostic Laboratory, San Gabriel, Box 255, California, 91778. Price of the proceedings is $6.00.

Avian Influenza

In late June and early July, a flock of 12,000 turkeys in Westmoreland County, Pennsylvania suffered a respiratory disease with
a mortality which increased from 0 to 25% as the disease progressed through 3 pens. Virus was not isolated from the tissues. However, influenza type A antibodies were detected in serum samples tested by the Veterinary Service laboratory. The antibodies were characterized as being compatible to A/Turkey/Oregon/71 with some cross reaction with a strain of equine influenza.

In early October, a similar disease condition in a flock of turkey meat birds approximately 15 miles south of the flock described above was reported. Attempts to isolate virus and to determine antibody to influenza A virus are in progress at this time.

Dr. W. Butterfield presented the influenza subcommittee report. Influenza A virus caused over 50% mortality in three chicken laying flocks in Alabama in October-November 1975. This is the first influenza outbreak in chickens in the United States since 1929 when fowl plague was eradicated from the U.S.

Outbreaks of influenza in turkeys were reported in Pennsylvania, Minnesota and Ohio. The virus isolated from turkeys in Ohio was isolated from swine on the same farm and the hemagglutinin was characterized as swine influenza A virus.

In January 1976 a virus reported to be fowl plague virus was isolated from two poultry flocks in Victoria, Australia. Approximately 40,000 chickens as well as 20,000 ducks were destroyed because of serologic evidence of exposure to the virus. The Australian Bureau of Animal Health declared the disease eradicated and the country free of fowl plague in late February, 1976.

In view of the increased occurrence of avian influenza, Newcastle Disease and hemagglutinating viruses that are being recovered from imported pet and other birds and the occurrence of outbreaks in chickens and turkeys caused by these hemagglutinating viruses, this committee strongly urges the USDA to provide increased funding, both intra-and extra-murally, for investigators and research to identify, classify fowl plague and other avian hemagglutinating viruses and the diseases they manifest.

Further to direct the USDA to define diseases caused by avian hemagglutinating viruses such as fowl plague and to develop contingency plans and legislation to control disease outbreaks caused by these agents.

**Avian Importations into the UNITED STATES**

The United States Department of Agriculture has approved 35 privately operated quarantine facilities for commercial shipments of birds. Fifteen of these have been approved since June 30, 1975. The facilities exist at 10 of the 15 designated ports of entry: New York (1); Detroit, Michigan (2); Chicago, Illinois (3); Brownsville, Texas (1); Los Angeles, California (15); Miami, Florida (9); Honolulu,
Hawaii (1); New Orleans, Louisiana (1); San Francisco, California (1); and San Ysidro, California (1).

Since the program began in January, 1974 approximately 400,000 birds have been imported. For fiscal year 1976, 13 of the 145 lots offered for entry were refused (9.0%). The latest laboratory confirmation for Newcastle disease virus was on November 5, 1976. Prior to this isolation, a two month period had elapsed without any birds being refused entry. All the lots refused entry were due to isolations of velogenic viscerotropic Newcastle disease virus except two which were refused because of a mixed viral infection which killed test chickens. Over 50% of these isolations were from Psittacines.

Personally owned pet bird importations increased slightly in fiscal year 1976 to 1,849 lots of which 165 (9%) could not be located after entry. The Poultry Health Committee which is an advisory group to the USDA recommended in October 1976 to rescind the present import procedures for pet birds.

During the fiscal year 1976, the U.S. Department of Agriculture operated quarantine facilities handled the following avian species for quarantine purposes: 2,576 pigeons; 1,131 chickens; 99 doves; 66 ducks; 24 pheasants; others—121; for a total of 4,117. In addition to this, 2,938,000 day-old chicks and poults were allowed entry as well as 4,239,000 hatching eggs.

The Committee on Transmissible Diseases of Poultry in 1975 recommended an increase of import station staff. Twenty-two new staff members have been added.

Salmonella

Veterinary Services is presently providing and will continue to provide on request salmonella serotyping service to State diagnostic laboratories. There are more requests for salmonella serotyping than there are funds and personnel to perform the service. The AAAP Disease Report Summary—1975 indicated that Salmonellosis is the fifth most frequently reported identified disease of poultry. In Fiscal Year 1976 and including the transition quarter, 5,696 cultures of salmonella were serotyped. This compares to 4,591 serotyped cultures in 1975. During 1967-74, 36,558 cultures of Salmonella were serotyped; 60.8 percent of those serotyped were isolated from chickens and turkeys, 14.1 percent were from swine and 15.2 percent from cattle. This does not infer that chickens and turkeys are more commonly infected with salmonellosis. It does point up the extreme interest that the poultry industry has in identifying their problem.

In 1978, salmonellosis activity in the United States will continue at about the same level as in Fiscal Year 1977, i.e., there will be no field activity. It is possible that in FY 1979, there could be field ac-
tivity in Salmonella depending upon the recommendations of the Secretary's Advisory Committee on Salmonella.

A paper entitled "Field Applications of the Microagglutination and Microantiglobulin Tests for the Detection of Avian Salmonellosis" was presented by Dr. J. E. Williams and is published in these proceedings.

**National Poultry Health Programs**

A progress report was made by the subcommittee on current national poultry health programs and relationship with APHIS. The subcommittee submitted the following report:

The General Conference Committee (GCC) of the National Poultry Improvement Plan (NPIP) approved and introduced a proposal to the state delegates of the 1976 Biennial NPIP Conference, Boston (July) that ARS and APHIS share responsibility for the implementation of NPIP programs in the future. This proposal was defeated by a vote of 72 No and 66 Yes.

This vote demonstrated the majority feeling of NPIP delegates that they do not desire formal involvement with APHIS in the NPIP. It also demonstrated that a sizable minority of the delegates do favor some formal ARS-APHIS relationship in the implementation of NPIP programs.

At our last meeting, we indicated our subcommittee's support of the General Conference Committee's proposal to investigate a formal ARS-APHIS relationship to NPIP. We noted that such a relationship could serve to bring about the necessary, but presently lacking, industry input into APHIS poultry programs.

Since GCC's proposal was defeated this July, this means that our subcommittee must now look to some other means to bring about effective and representative state poultry industry involvement in decision making processes affecting APHIS poultry health programs. The recent NPIP vote was decisive and further pursuit of NPIP as the potential industry input vehicle into APHIS programs does not appear productive.

It is recommended that this coming year be devoted to exploring, developing, and recommending alternative means to bring about the needed industry-APHIS relationship in national poultry health programs. Following a lively discussion it was learned that APHIS will continue to recognize states according to standards and procedures as recommended for uniform methods and rules by the U.S. Animal Health Association and the American Association of Avian Pathologists and participation in the National Poultry Improvement Plan (turkeys) as described in title 9 CFR, Chapter IV, subchapter A, Part 445, subparts A and D.
The standards as published in Veterinary Services Memorandum 565.1 are the basis for cooperative State-Federal pullorum disease and fowl typhoid disease eradication in turkeys and recognition by Veterinary Services of states participating.

Advisory Committee to the Secretary of Agriculture

An advisory group to the Secretary of Agriculture for poultry health has been formulated. Its first meeting was scheduled for October 5, 1976. This group, representing all facets of industry, should furnish improved guidelines and direction for Veterinary Services programs in the future.

Miscellaneous

Dr. E. Bryant, reported on the meeting of the New England Poultry Health Roundtable who wish to re-emphasize and endorse our last years recommendation on the importance of washing of crates used for movement of birds especially when crossing state lines.

The Rountable also requested the need for information pertaining to characteristics of virus strains used in poultry vaccines with particular reference to evaluating the pathogenicity of these strains. The group also expressed a need for a diagnostic laboratory for the Northeast area which raises 50-60% of the U.S. broiler breeder stock.

A subcommittee was formed to study the location of laboratories that could assist the state diagnostic units with more elaborate and special techniques, required for in-depth investigations of unusual cases.

An accession fee or charge basis for diagnostic services was discussed for state laboratories but some states constitutions forbid such charges.

The following subcommittees were formed:


U.S. Poultry Health Advisory Committee to APHIS: E. Bryant, H. Goldstein, R. Hogue, I. Peterson, B. Pomeroy, T. Ryan and R. McCapes, chairman.


Mycoplasmosis: To be named.
FIELD APPLICATIONS OF MA AND MAG TESTS FOR DETECTION OF AVIAN SALMONELLOSIS

J. E. Williams, DVM, PhD and A. D. Whittemore, BS

SUMMARY

Field studies were conducted to evaluate the efficacy and specificity of the microagglutination (MA) and microantiglobulin (MAG) tests along with bacteriologic culture of birds and litter for the detection of salmonella infections in chickens and turkeys. The MA test is being effectively applied in the serologic testing programs of 3 states for the detection of pullorum-typhoid and Salmonella typhimurium infections.

The MAG test used with bird and litter culture proved to be the most reliable means of detecting naturally occurring salmonella infections in multiplier chicken flocks. Through use of the MAG test, some specific pathogen free flocks were shown to be free of exposure to salmonella infections. The method also proved beneficial when applied to the detection of salmonella infection introduced into field turkey flocks through the feed.

Confirmation of serologic test results by isolation of specific salmonella serogroups from positive and suspect serologic reactors also confirmed the efficacy of the methods used in these studies. The MAG test procedure did not prove to be so sensitive as to result in false positives.

INTRODUCTION

Because of the known low sensitivity of conventional serologic testing methods for paratyphoid infections of poultry, a search was made for improved methods that might lend themselves to more widespread application. Results showed that microtest methods could be advantageously applied for the serologic detection of most types of avian salmonellosis.

The microagglutination (MA) test was first applied for the detection of pullorum-typhoid (group D) infection and later extended to the detection of other salmonella infections of poultry including Salmonella typhimurium (group B) and salmonella group C infections. In 1972, the MA test was recognized as an official testing method under the National Poultry Improvement Plan for detection of pullorum-typhoid and S. typhimurium infection. Smyser reported the MA test to show complete agreement with the tube agglutination test in detecting chickens infected with pullorum disease.
The microantiglobulin (MAG) test, based on the technique of Coombs et al., was reported first for the detection of S. typhimurium paratyphoid infection. This test was more sensitive than conventional procedures and very valuable in the detection of poultry potentially carrying paratyphoid infections.

Kumar et al. reported that the MAG test was superior to all other tests in detecting turkeys infected with S. typhimurium. Snoeyenbos has expressed his concern about the appropriate diagnostic dilution to accept as positive for the MAG test. Zecha has successfully used the MAG test in detecting paratyphoid infections in turkeys during the Dillon Beach studies in California.

Williams reported field applications of the MAG test which was found to be effective and specific in detecting salmonella group infections and in accrediting flocks as free of exposure to these infections. Williams and Whittemore reported the MAG test to be very effective in detecting S. typhimurium laboratory infections in chickens. The MAG titers remained positive long after many of the birds had ceased to carry the organisms. In further laboratory studies, Williams and Whittemore reported the MAG test to be the most sensitive and reliable procedure for detecting carriers of S. typhimurium infection in chicken flocks.

Subsequent to our laboratory studies, we field tested the MAG test for the detection of salmonella group B, C, and D infections in commercial and institutional poultry flocks. These field studies were begun in 1972 and have continued to the present time, and the findings of these studies are discussed in this report.

MATERIALS AND METHODS

Diagnostic serology. All MA tests for pullorum-typhoid and for S. typhimurium were applied according to standard procedures in state serology laboratories (Maine, Virginia, Arkansas) on routinely collected serum samples.

Field flock selections. Three types of field chicken and turkey flocks of varying ages were selected for laboratory study: 1) multiplier type chicken flocks maintained under commercial production conditions; 2) chicken flocks kept under tight security and isolation or maintained in positive pressure housing with filtered air (FAPP) or both. These flocks were studied because we recommended a program involving MA-MAG testing along with litter, cloacal swab, and feed culturing to monitor the status of salmonella infections in specific-pathogen-free (SPF) flocks; and 3) commerical turkey flocks.

In some experiments, floor litter samples were collected and submitted for culture at the time blood samples were taken for serology.
For the multiplier type chicken flocks, white wing badges were used to aid in the rapid identification of all birds selected for serologic and cultural examination. This permitted birds of interest to be readily collected for cultural examination after the results of serologic tests were known.

**Blood sample collection.** For routine serology, in some state laboratories, serum samples were transferred to microtest plates before MA tests were set up; in others, samples from conventional tubes were used.

In the study of multiplier-type chicken flocks, serum samples were collected at the time *Mycoplasma gallisepticum* serum samples were taken. For all field flock studies, fresh blood samples were deposited into tubes in the usual way; either direct wing vein puncture or syringe and needle were used. When the serum was collected, about 0.2 ml. of each sample was transferred with a Pasteur pipette into a well of a regular 96-well microtest plate. In an effort to facilitate shipping and convenience of reporting in the multiplier-type flock studies, 48 samples from each pen were collected and transferred into one-half of a microplate.

Field samples were immediately frozen and then transported to the Southeast Poultry Research Laboratory packed in dry ice and accompanied by a form with appropriate band number information. Receiving samples that were already transferred to microtest plates considerably facilitated our laboratory tests.

**SeroLogic test procedures.** Only microtests conducted and interpreted according to standard procedures were used in performing the serologic tests used in these studies. In the MAG test, a reaction at a dilution of 1:40 was interpreted as positive and a reaction at dilution of 1:20 was interpreted as a suspicious reaction.

**Cultural procedures.** Standard laboratory procedures already described were used for litter and bird organ cultures during this study.

### RESULTS

**Diagnostic Serology**

Maine was the first state to apply the MA test in June, 1973 as a routine procedure in its salmonella serology programs.

The MA procedure was used for all tests. A total of about 106,000 pullorum-typhoid MA tests have been conducted each year. No confirmed reactors were detected. About 40 suspicious reactors were cultured last year, with 2 positive paratyphoid isolations (*S. enteritidis* and *S. senftenberg*). Microtests were not run for *S. typhimurium* infection.
Virginia began its salmonella microtest program in 1975. Last year about 25,000 serum samples from chickens and 158,000 serum samples from turkeys were tested for pullorum-typhoid and \textit{S. typhimurium}; the MA test procedure was used. No pullorum-typhoid reactors were detected. A few suspicious reactors with both pullorum and \textit{S. typhimurium} antigens have been detected. Isolates from suspicious reactors have included arizonae, \textit{S. heidelberg}, and other serologically related salmonellae.

Arkansas began its microtest program for avian salmonella infections in 1976; and in a 3 month period, about 60,000 chickens and 9,000 turkeys were tested for pullorum-typhoid and \textit{S. typhimurium}. No culture-confirmed reactors were detected during this period.

All 3 of these laboratories have been well pleased with the MA test for avian salmonella serology because of the savings of time, space, and cost. No special difficulties or problems in applying the MA test on a routine basis have been encountered.

\textbf{Field Flock Selections}

\textit{Multiplier type chicken flocks.} Early in 1972, a commercial breeder approached us for help to set up a monitoring program for salmonella infections in replacement flocks. The organization had been experiencing some problems with a salmonella group B organism (\textit{S. heidelberg}). Because the state and national avian salmonella testing programs do not officially recognize any salmonella other than pullorum-typhoid organisms and \textit{S. typhimurium}, conventional serologic testing programs were unable to effectively detect the salmonella infections during this specialized monitoring program. The state officials did agree to culture selected positive and suspicious reactors and also the litter.

From July, 1972 through January, 1975 (30-month period), we conducted the MAG test on 9,072 samples, 4,368 of which had been banded for potential culture after the MAG test results were available. The 9,072 samples represented a monitoring sample of 1.43\%, which was well below the recommended number of samples to be taken in a monitoring program.\footnote{25}

Among the samples from banded birds, we detected 168 (3.84\%) positive reactors and 315 (7.21\%) suspicious reactors; whereas, among the samples from the unbanded birds, we detected 181 (3.84\%) and 299 (6.36\%) suspicious reactors. Sixty-one positive reactors were cultured and 19 (31.14\%) of these were infected with salmonella group B organisms (\textit{S. heidelberg}); 74 suspicious reactors were cultured, and 18 (24.32\%) of these were infected with the same group B organism. Only this one serotype was consistently isolated from these birds.

A total of 147 litter samples were submitted for culture. Twenty-
six (17.69%) of these were positive for the same salmonella group B organism that had been found in the birds that had been raised on the litter.

**SPF flocks.** The poultry industry is fast approaching the time when all baby chicks will be pathogen-free when they hatch. In 1964, a large commercial firm began the development of a group of SPF chicken flocks with complete isolation in closed filtered-air houses. The first generation in the SPF environment tested free of most common poultry pathogens by the fourth generation. In 1973, paratyphoid infections in salmonella groups B, C, and D were included among the disease agents for which the flocks were monitored. When the birds were 8 weeks old, our laboratory screened approximately 250 serum samples from these SPF flocks; the MAG test was used for salmonella groups B, C, and D with negative results. Findings were similar when experimental chicken flocks maintained in FAPP houses on isolated laboratory premises were tested.

Some SPF flocks that we have tested have revealed positive reactions to the MAG test for salmonella group B, C, and D with titers of 1:160 or higher. These results indicate that these SPF birds have been exposed to salmonella organisms, probably through their feed or their environment. In such flocks, cultural examinations of the litter and feed as well as the birds themselves are recommended.

**Turkeys.** During field studies in the Dillon Beach project in California, about 60,000 MAG tests were conducted on turkey serum samples from birds in experimental groups. The test was successful in detecting and confirming a group C (*S. tennessee*) paratyphoid infection that was apparently introduced into the flocks with contaminated feed. At 18 weeks of age, 4.8% of the birds were positive to group C by the MAG test. Twenty-four of these reactors were autopsied and cultured. *S. tennessee* was isolated from the crop and intestines of 3 reactors. The MAG test was found particularly effective and easy to apply in screening the Dillon Beach flocks.

**DISCUSSION**

Microtest serology in which the MA test is used has been successfully applied under field conditions in routine state testing programs for pullorum-typhoid and *S. typhimurium* infection in 3 states. We expect other states to adopt the MA test for their programs in the future. Interest has also been expressed in an MA test for *M. gallisepticum*, to be used along with the salmonella microtests, and we hope that such a test procedure can be developed. Our laboratory has entered into cooperative field programs with 6 states; we provide technical training for about 12 laboratory workers and supply microtest antigens for use in state testing programs. These antigens will soon be available commercially.
Interestingly, in the multiplier-type chicken flock studies, the MAG test was successful in detecting birds infected with salmonella organisms when only about 1.5% of the birds were serologically screened. These results clearly show the ineffectiveness of the MA test alone to detect the paratyphoid infections involved in these flocks. The use of the MAG test was essential for this detection. In establishing monitoring programs for avian salmonella infections, litter culture as well as serologic examinations is essential for maximum detection of contamination.

The specificity of the MAG test was shown by the work done on these multiplier-type chicken flocks; approximately 31% of the positive reactors and 24% of the suspicious reactors cultured yielded a salmonella group B organism. The litter was also positive for the same salmonella group B organism as the birds that had been grown on it.

The finding of certain SPF flocks that are serologically negative to the MAG test for salmonella group B, C, and D infections is not in itself unique, but it does show that with proper effort, flocks free of exposure to the major salmonella serogroups can be established. The findings in these SPF flocks is certainly different from experience under field conditions in serologically screening routine production flocks. In all the latter tests, the number of reactors to the salmonella MAG tests has been high. We feel that in any application of the MAG test to the general poultry population, many exposed birds will be detected.

The MAG test appeared to work as well for turkeys as for chickens. In conducting the test with turkey serum, we found that the rabbit chicken antiglobulin serum enhanced the reactions to the same degree as it enhanced the reactions of positive chicken serum.

The main application of microtest serology in the future, especially the MAG test, may be for detecting centers of group B, C, and D salmonella infections in specific chicken and turkey flocks and in accrediting those that are free of exposure to the major salmonella infections. Microtest serology should be a part of the salmonella monitoring program for all poultry flocks. Further research is presently in progress on methods for preparing satisfactory group E microtest antigens.
REFERENCES


WINNING SUPPORT FOR ANIMAL HEALTH
Lloyd Faulkner, DVM, PhD*

Members of the United States Animal Health Association: I am pleased and grateful to have this opportunity to communicate with you.

Normally, as Roland Gessert has probably explained, I am a professor and chairman of the Department of Physiology and Biophysics in the College of Veterinary Medicine and Biomedical Sciences at Colorado State University.

But today, I write this from the Dirksen Senate Office Building in Washington, D. C. I am here as a congressional science fellow, in a program organized and implemented by the American Association for the Advancement of Science. The Federation of American Societies for Experimental Biology sponsors my fellowship.

How did I get here? It started about two years ago, when, as a member of the AVMA's council on research, I resolved to do something to enhance the image of veterinary medicine, in general, and federal support for the programs of the profession, specifically.

As a veterinary educator, researcher and member of the research council, I had experienced the frustrations of the conviction that the importance of veterinary medicine was not matched by appropriate governmental appreciation and support.

Associated with that concern, I questioned whether the AVMA was sufficiently progressive and responsive to segments of the profession to meet a diversity of critical needs of an expansive profession in 1976 and beyond. Certainly, the AVMA should represent the practitioner well. Practitioners are the backbone of the profession and by far the most numerous constituents of the AVMA.

But practitioners are only a part of the infrastructure of the AVMA, a part of a greater whole. Moreover, the national image of veterinary medicine is predominantly shaped by segments of the profession that are more nationally visible than a diffuse collection of perceptions of local practitioners. The national image touches every practitioner to a greater or lesser degree.

If one wants to influence the system, he must have ready access to the power structure. I entered the race for the AVMA Executive Board from District IX and won. I'm pleased to report that many of my fears for the administration of the AVMA have been allayed. That does not mean that I have not found things that disturb me—sometimes greatly—but I have found an executive board where a

*Fort Collins, CO.

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member can speak up freely, receive serious consideration and find allies for progressive thought.

I found, in fact, a healthy mix of a variety of viewpoints among members of the executive board. The AVMA staff is meticulously dedicated to implementing the will of the house of delegates and the executive board. No one, contrary to former perceptions, rules the house of delegates. The delegates are uninhibited in the best democratic fashion, articulate and free-thinking.

With respect to our image—I believe the AVMA, practitioners and veterinary scientists, in particular, have been insensitive to the needs of the publics we serve—the people and the institutions that use and buy what we have to offer.

We are beginning to pay our dues, I think, for that lack of sensitivity. Support for education and research is declining—especially in terms of real dollars. Support for military and other governmental veterinarians wanes. Federal and state trade commissions and departments of justice are examining professional standards—standards that we apparently set in concrete in decades past and have failed to examine since. Most notably, we have never bothered to ask for or listen to public perceptions of our standards—the guild has been closed to outsiders and their opinions. Most of us probably have never questioned our standards. Neither did we bother to explain our positions—assuming that professionalism was its own justification.

We have held dear to concepts laid on us as inviolate by a dusty but kindly old prof in veterinary jurisprudence. The standards were probably reinforced by one or more crusty old practitioners on the State Board of Examiners. Most of us have probably never thought seriously about our code, except in the context of self interest. I don’t at all mean that our standards of professionalism are wrong or even contrary to the public good. I do think we must evaluate them to be sure they are not just self-servicing rhetoric hiding behind the cloak of respectability. I do think veterinary medicine has its justification in service, and standards of conduct must be consistent with the most good in the interest of the public, and the burden of proof is upon us.

Science and medicine ennoble our principles. We live with those principles daily—science and medicine are our daily lives. We neglect to consider that the public does not view science and medicine with our eyes—our beloved profession is only a utility in their view. Veterinary researchers and practitioners must be devoted to new knowledge and understanding to escape obsolescence—thus, we are committed and devoted to communicating with other veterinary researchers and practitioners. In that, we tend to isolate ourselves—and insulate ourselves—from our consumers.
We address our publics as though they were we. Or, just as inappropriately, we talk to them or at them and not with them. Is it uncommon in your experience for an authoritative veterinary lecturer to flash a slide on the screen that cannot be read much beyond the speaker’s lectern? Too many of us are technically incompetent communicators. Worse, too many of us demonstrate a disregard for those who would love to hear what we have to say—those who would dearly like to be allies of veterinary medicine.

Faced with the consequences of provincial, isolationist behavior, we are beginning to appreciate the need to communicate our values and needs to the public—and to the government in which the power of the people rests. We find, unfortunately, that we are ill-prepared to communicate effectively outside the professional and scientific communities. In fact, we have poorly learned to communicate freely among segments of our own profession and among the disciplines of science.

If we are to influence politicians, they must fully understand the importance of veterinary medicine to the people who vote to put them in office. If a politician is to serve the people, his first mission is to gain and maintain the support of the voting public. Just as surely, the public votes for veterinary science by its active support, by its opposition, or by its silence on the issues that affect veterinary medicine. We must not expect, nor would it be healthy for us, to escape all criticism. On the other hand, we could escape a good deal of legitimate criticism if, instead of constantly reacting to issues, we would listen, anticipate, exercise self-discipline and communicate.

So, I greet you from Washington. I have taken the leap into the public domain. I hope to learn the system and meet the people that make the decisions. I hope to get into their heads and to acquaint them with a veterinary scientist. I don’t know if I can do much to prevent the dismantling of the Bureau of Veterinary Medicine in the Food and Drug Administration, but I’ll try. Most of all, I hope I am effective, in some small way, in contributing some good to the profession which has been so good and means so much to me.
I'm pleased to have been given the opportunity to speak to this group today. It is particularly important that individuals concerned with animal disease and public health be thoroughly informed on issues involved in the use of antibiotics in animal feeds. Recently the Bureau of Veterinary Medicine of the Food and Drug Administration has re-examined this issue, and a multi-discipline advisory committee, of which I am a member, is in the process of drafting their recommendations concerning the use of antibacterial drugs in animal feed.

When looking at the use of drugs in food-producing animals, there are two safety issues which should be understood and separated as much as possible. One area of concern for both FDA and the U.S. Department of Agriculture is the experience of drug residues in meat, milk, and eggs. Drug metabolism studies, adequate drug withdrawal times before slaughter, and proper labeling all help assure control of the presence of drugs or their metabolites in man's food.

The second issue is the one which we'll discuss today. This issue concerns the effect of antibacterial drugs on bacteria in the gastrointestinal tract of animals, the development of drug resistance, and resistance transfer between the intestinal bacteria. It is in these enteric organisms that an extrachromosomal piece of DNA—termed a plasmids transferred widely among microorganisms by a process resembling mating. Certain plasmids, sometimes called R-factors, carrying genes for drug resistance may be selectively favored by the use of antibiotics.

For some 25 years antibacterial drugs have been widely used in the feed of food-producing animals in this country. These drugs are used for increasing rate of weight gain, improving feed efficiency, and/or for prevention and control of animal disease. Some of the drugs, which are used at subtherapeutic levels in animal feeds, are also used for therapy of disease in both man and animals.

In the middle 1960's, scientists and regulatory agencies throughout the world began to look more closely at the practice of using antibacterial drugs in feed, and more specifically, at the potential problems which might be created due to emergence of transferable multiple-drug resistance in bacteria. While several groups had reviewed these problems earlier, the most significant reports and recommendations were those published by the Swann Committee in Great Britain in 1969 and by the Food and Drug Administration Task Force in the U. S. in 1972.

*Manhattan, Kansas

**Report to the National Advisory Food and Drug Committee
The Swann Committee, a joint committee on the use of antibiotics in Animal Husbandry and Veterinary Medicine, was appointed by the British Ministry in 1968. This committee was charged with obtaining information about present and prospective uses of antibiotics in animal husbandry and veterinary medicine, with particular reference to the phenomenon of infective drug resistance, to consider the implications for animal husbandry and for human and animal health, and to make recommendations.

The event which triggered the appointment of the Swann Committee was an epidemic of *Salmonella typhimurium* type 29 infection in calves which began in 1964, peaked in 1965 and subsided in 1966. This infection spread to humans. Of 2,500 cultures of human *S. typhimurium* submitted to the enteric reference laboratory in London in 1965, 23% were phage type 29 and about the same proportion were antibiotic resistant. In the same year, of about 2,000 cultures of bovine *S. typhimurium*, 73% were phage type 29 and almost all were antibiotic resistant. Thus, the type 29 epidemic played a much larger role in the disease in calves than in humans. However, many of the human cases were people in close contact with infected calves. It appeared likely that the people derived their infection from the calves. This epidemic was confined largely to calves in “intensive” or confined rearing. In this instance, calves were gathered from various farms shortly after birth, shipped to a collecting point, then on to a farm where they would be fed for several months. Some of the dealers were apparently careless in their management and hygiene. Calves were crowded into dirty vehicles and conditions were ideal for the spread of disease. When the epidemic was at its height, large amounts of antibiotics were used in the attempt to prevent or treat the disease. These attempts were largely futile because the organism had become resistant to most of the commonly used drugs.

The Swann report was based upon evidence drawn from expert witnesses and from selected publications and was published in November 1969.

As a basis for review, the Swann Committee grouped antibiotics into “feed” antibiotics and “therapeutic” antibiotics. Recognizing the usefulness of therapeutic antibiotics for treating diseases in animals and man, the Committee recommended against their use at low levels in feed. The purpose of this recommendation was to reserve the use of therapeutic antibiotics for treatment of disease and to reduce the development of resistance to those drugs valuable for combating disease. The committee further recommended that therapeutic uses of antibiotics (and synthetic antibacterial agents) be limited to use on prescription by veterinarians. A second group of drugs, the feed antibiotics, consisted of those which were not used to treat disease, which did not usually produce multiple drug resistance, and which were not known to cause the transfer of resistance. These “Feed” use antibacterials were not restricted to veterinary prescription.
Meanwhile, in the United States, the subject of antibiotic feed use was also under examination. In April 1970, the Commissioner of the Food and Drug Administration established a task force to undertake comprehensive review of the use of antibiotics in animal feeds. The scientists included ten specialists on infectious diseases and animal science from FDA, the National Institutes of Health, the U. S. Department of Agriculture, the Center for Disease Control, and five consultants from universities and industry.

In January, 1972, the Task Force listed their major concerns and recommendations. Among these were:

1) The *Salmonella* reservoir: The Task Force indicated that the subtherapeutic use of antibacterials should not produce an increase in quantity, prevalence, or duration of shedding of *Salmonella*, nor an increase in the proportion of drug-resistant *Salmonella*.

2) The transfer of Drug Resistance: The Task Force noted that exposure to certain antibiotics could promote drug resistance in bacteria and that, in many cases, the resistance was transferable to other bacteria. They further noted a potential hazard in that these bacteria might be transmitted to man.

3) The treatment of clinical disease in animals: The Task Force concern was whether use of subtherapeutic levels of an antibacterial drug in feed would compromise subsequent treatment of clinical disease in the animal, should disease occur. They asked—Are the same drugs effective for treatment? Or must other drugs be used?

Based on these concerns and recommendations specific criteria were developed for areas of human health, animal health, and drug effectiveness. These criteria served as guides for drug sponsors in producing studies designed to help answer the questions raised by the Task Force.

On April 20, 1973, FDA published in the Federal Register the final order implementing the recommendations of the Antibiotics Task Force and notifying drug sponsors of the necessary steps to be taken if marketing of subtherapeutic uses of antibacterial drugs was to continue. In addition to drug efficacy on combination products, drug sponsors were asked to submit data concerning the shedding of salmonella and the development of bacterial drug resistance in animals fed antibiotics. The studies were to be performed in pigs, chickens, and calves.

Results of studies assessing the effect of certain priority drugs (tetracyclines, streptomycin, dihydrostreptomycin, sulfonamides, and penicillin) on the salmonella reservoir were required by April 20, 1974. A second group of experiments were scheduled involving "all other antibacterial drugs" (i.e., bacitracin, flavomycin, tylosin, and nitrofurans); data from these studies were due no later than April 20, 1975.
Research was also scheduled and carried out in FDA laboratories, and through contracts sponsored by both FDA and industry, in the effort to address the Salmonella issue and other problems posed by the Task Force. Taken together with data published in the literature, it was hoped that information derived from the new studies would conclusively resolve the issues.

The Food and Drug Administration made efforts to involve the public, the scientific community and the animal industry in the Antibiotics in Feed Review. Outside experts were utilized as consultants. Consumers and industry were informed about the program through fact sheets, press releases, and speeches; reports were made to the National Advisory Veterinary Medical Committee, and subsequently to the National Advisory Food and Drug Committee. As the Food and Drug Administration entered the decision-making phase of the program, the NAFDC asked to be actively involved in the attempt to resolve some of the difficult policy issues involved. The Committee elected to form a three member subcommittee charged to study the problems and report back to the full Committee.

That Subcommittee consists of myself; Dr. Nelson Fernandez, a physician and nutritionist at the University of Puerto Rico; and Ms. Camille Haney, a consumer affairs expert from Wisconsin. The expertise of these individuals was supplemented by that of outside consultants: Dr. William Flatt, from the Agricultural Experiment Station, University of Georgia; Dr. Edward Hook, an expert on Salmonella from the University of Virginia Medical School; Dr. Stanley Falkow, an outstanding authority on infectious drug resistance from the University of Washington Medical School; and Dr. George Poppensiek, a professor of microbiology from the New York State College of Veterinary Medicine at Cornell University.

The charge to the subcommittee was to consider the risks and benefits involved with the use of a number of antibiotics and sulfonamides and to reach judgements as to whether or not the use of these drugs is worthwhile. The subcommittee was told that there were a number of factors that should enter into their assessment:

1. Is there a risk? What is the extent and nature of that risk, and should it be accepted by consumers?
2. What are the alternatives to the use of these drugs, either in the use of other drugs or in the use of non-drug methods?
3. If we should accept the use of these drugs and the risks involved, are there restrictions that should be imposed and what are those restrictions?

The subcommittee conducted a series of four (4) meetings. These were held in January, April, July, and August of this year. During these meetings the Subcommittee heard data presented by FDA Staff and consultants on the tetracyclines, penicillin and sulfaquinoxaline. At the open public hearing portions of the meetings, the subcommit-
The Subcommittee recognized very early that the issues involved in the feeding of subtherapeutic levels of antibacterial drugs were extremely complex and controversial. There are apparent voids between established fact and the theoretical projections of current information. The extensive reviews presented to the subcommittee revealed disparity of opinion by competent scientists as to the significance of published research and previous use history.

The Subcommittee approached the task with the understanding that the stated policy of the FDA is to reduce and/or eliminate risk to the extent possible, and charged with weighing the risks or potential risks against the benefits derived from the use of antibacterial drugs in animal feeds.

It became apparent to the Subcommittee that benefits of increased rate of weight gain, improved feed efficiency, and the prevention and control of animal disease were present and could generally be quantified. However, the amount of risk to animal or human health due to use of antibacterial agents in animal feed could not be defined.

From the information presented at the four meetings, the Subcommittee summarized the available data on adverse effects as follows:

1. The Subtherapeutic use of antibacterial agents in animal feeds results in a selection for antibiotic-resistant microorganisms in animals.
2. There is an increase in the ecological pool of R-plasmids.
3. Under pressure of antibiotics, the transfer of R-plasmids from *E. coli* to *Salmonella typhimurium* can be demonstrated.

The experimental studies also show that, when animals fed low levels of antibacterial drugs are exposed to infecting numbers of drug-resistant salmonella organisms, the animals generally shed increased numbers of salmonella organisms. However, animals under the same antibiotic feeding conditions which are exposed only to drug-sensitive salmonella organisms are likely to shed similar or decreased numbers of organisms, when compared to non-medicated controls.

Experimentally, drug-resistant *E. coli* have been shown to pass from animals to man, with subsequent transfer or R-plasmids occurring in the humans. The techniques utilized in establishing the identity of these organisms, included sero and phage typing, DNA-DNA hybridization, compatibility grouping of plasmids, and use of genetic markers. Various investigators reported higher levels of bacteria resistant to antibiotics in farm families than in urban dwellers not exposed to antibacterial drugs in animal feed.

Passage of drug-resistant *Salmonella* from animals to man has been demonstrated, and human salmonella outbreaks have been traced to animals. Theoretically drug resistant bacteria should be
harder to treat. However, studies had not shown increased rates of death or disease in individuals exposed to farm animals given subtherapeutic levels of antibacterial agents. Furthermore experimental studies have not demonstrated reduced efficacy of therapeutic drugs, when animals previously given subtherapeutic dosages are treated subsequently for diseases.

Perhaps the major theoretical risk to animal and human health would be the transfer of single or multiple resistance plasmids from bacteria in the ecological pool into a clone of highly dangerous pathogens, with subsequent spread of drug-resistant disease. This has recently occurred under pressure of antibiotic therapy in man with the emergence of *Haemophilus influenzae*, *Neisseria gonorrhea* and *salmonella typhi* resistant to both ampicillin and chloramphenicol.

While the risks are of unknown magnitude, due in part to lack of documentation, it appears prudent, when possible, to curtail feed use of those antibacterial drug products such as penicillin and tetracyclines, which are also used for therapy in man and which induce cross-resistance to drugs used for therapy in man. Simultaneously, the subcommittee recognized that there would be a considerable loss of benefits from a total ban of the use of antibiotics in feeds. Such ban would result in:

(A) Increased cost and/or diminished supply of food of animal origin.

(B) Reduced health status of animals with subsequent effect on the food products of animal origin entering the nation's food supply.

In most cases, alternate drugs exist for promotion of feed efficiency and growth rate in food animals. These alternatives are considered to be effective, economically acceptable, and unlikely to encourage transfer of multiple resistance to enteric organisms. However, satisfactory alternates do not exist in all cases for prevention of disease. The challenge, then, is to identify those drugs and uses which can be reduced or eliminated with the goal to reduce the pool of drug-resistant organisms while retaining demonstrated benefits, such as the prevention of disease to protect the wholesomeness of the food supply.

In consideration of the above, and after thorough review of available data presented by FDA, and by university and industry scientists, these specific recommendations are being submitted to the NAFDC. They will be considered by the NAFDC in January of 1977.

The recommendations are for:

**Penicillin**

1. Discontinue use in all species for purposes of growth promotion and/or feed efficiency.
2. Discontinue use for those instances of disease prevention where effective substitutes are available.
Sulfaguinoxaline

Continue use for disease control as approved for chickens, turkeys and rabbits. This use is to be limited to the extent possible, to those periods of time for which the presence of the drug in the feed is necessary due to the threat of animal disease.

Tetracycline

1. Discontinue use for growth promotion and/or feed efficiency in all species for which effective substitutes are available.

2. Continue use for disease prevention where effective alternates are available and as approved for the various species. This use is to be limited, to the extent possible, to those periods of time for which the presence of the drug in the feed of a particular animal species is necessary due to the threat of animal disease.

In addition, the Subcommittee is making a number of general recommendations for activities to be carried out by the Bureau of Veterinary Medicine. These include the following:

1. The establishment of regulatory measures that will assure that the antibacterial drugs are used in a judicious manner, by limiting sale of products containing tetracyclines and penicillin to feed mills and/or producers who are the holders of an approved Medicated Feed Application. However, the Subcommittee recognizes that such action removes the product from use by a practicing veterinarian if he is not the owner of a registered feed mill. With this in mind, the subcommittee further recommends that an order from a licensed veterinarian be recognized as a second means of distribution of these products and that each of these procedures be carefully monitored to assure compliance.

2. Monitor the incidence and transfer of antimicrobial resistance in human and animal pathogens and the move to establish a baseline of current antibiotic resistance for use in future evaluations.

3. Evaluation of the effects of implementation of national recommendations in other countries.

4. Re-evaluate within 5 years, the effect of the subtherapeutic uses of antimicrobial products in animal feeds in this country.

5. Establish the magnitude and define the future significance of the human health risk.
6. Affirm that the long range goal of FDA is the elimination from low level animal feed use, those drugs also used for therapy of disease in man. This might be accomplished by encouraging the development of satisfactory alternative measures for disease prevention in animals; e.g., substitute drugs, vaccines, new husbandry practices and genetic improvements.

7. Promote research on new, non-drug methods for improving feed efficiency and weight gain.
Dr. Donald Gable of the Food and Drug Administration discussed aspects of the FDA Bio-Research Monitoring Program. Proposed regulations will appear in the Federal Register; these regulations are intended to correct deficiencies in certain toxicological testing laboratories detected earlier this year by FDA.

Regulations affecting the conduct of clinical efficacy studies of human and animal drugs also are being proposed. The committee is concerned that certain provisions of such regulations as outlined by Dr. Gable may severely restrict the ability to conduct animal drug clinical efficacy evaluations. The committee believes that existing regulations are adequate to assure development of data to confirm animal drug effectiveness. We are concerned that unjustified new animal drug regulations may be promulgated as an over-reaction to correcting possible deficiencies in human clinical evaluations.

The committee is unaware that the safety and efficacy of pharmaceuticals for animal health have suffered due to lack of proper laboratory practices and animal laboratory facilities. Therefore, the committee urges the FDA to carefully consider the unique and varied problems involved in conducting clinical evaluations on animal drugs before proposing regulations which may inhibit the research and development of drugs for veterinary medical use.

During the past several years the committee has recognized the problem of a lack of adequate drugs for minor uses in animals. With the ever increasing requirements in establishing safety, efficacy, and residue tolerances, research costs frequently are not justified by potential market for such drugs.

During this past year several organizations have become active in attempting to solve the problem. These organizations include the Food and Drug Administration, American National Cattlemen’s Association, Sheep and Wool Growers, American Association of Industrial Veterinarians, Animal Health Institute, Beekeepers Associations, the Biologics Committee of the U.S.A.H.A. and others. During this past year the U.S.D.A. Residue Evaluation and Planning Staff, under the leadership of Dr. John Spaulding, together with the afore-
mentioned organizations, have begun to explore the possibility of a cooperative program to assemble data required for clearance of low volume use drugs. Such programs possibly would be similar to the existing IR-4 Program for agricultural pesticides. The Committee commends Dr. Spaulding and the U.S.D.A. for their efforts in attempting to solve the minor animal drug use problem, and continues to solicit the support of all interested organizations.

For the past several years the Committee has considered the effect or lack of effect to the public health from the use of subtherapeutic levels of antibiotics in animal feeds and this year invited Dr. Jacob Mosier, Chairman of the Subcommittee to the National Food and Drug Advisory Committee, to report to our Association. Any clear-cut adverse effects have been difficult to detect. While Dr. Mosier's Committee Report has not yet been finally adopted the following recommendations have been proposed:

*Penicillin:*

1. Discontinue use in all species for purposes of growth promotion and/or feed efficiency.
2. Discontinue use for those instances of disease prevention where effective substitutes are available.

*Sulfaquinoxaline*

Continue use for disease as approved for chickens, turkeys, and rabbits. This use is to be limited, to the extent possible, to those periods of time for which the presence of the drug in the feed is necessary due to the threat of animal diseases.

*Tetracycline*

1. Discontinue use for growth promotion and/or feed efficiency in all species for which effective substitutes are available.
2. Continue use for disease prevention where effective alternates are not available and as approved for the various species. This use is to be limited, to the extent possible, to those periods of time for which the presence of the drug in the feed of a particular animal species is necessary due to the threat of animal disease.

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2. Monitor the incidence and transfer of antimicrobial resistance in human and animal pathogens and the establishment of a baseline of current antibiotic resistance for use in future evaluations.

3. Evaluation of the effects of implementation of national recommendations in other countries.

4. Re-evaluate within 5 years, the effect of the subtherapeutic uses of antimicrobial products in animal feeds in this country.

5. Establish the magnitude and determine future significance of the human health risk.

6. Affirm that the long range goal of FDA is the elimination from low level animal feed use, those drugs also used for therapy of disease in man. This might be accomplished by encouraging the development of satisfactory alternative measures for disease prevention in animals; e.g., substitute drugs, vaccines, new husbandry practices and genetic improvements.

7. Promote research on new non-drug methods for improving feed efficiency and weight gain.

The Committee on Pharmaceuticals and Toxicology endorses the recommendations of Dr. Mosier's Subcommittee.

Dr. Lloyd Faulkner, Chairman and Professor of Physiology and Biophysics at Colorado State University, and also a member of the AVMA Executive Board, is currently serving as a Congressional Fellow, attached to the staff of Senator Mathias of Maryland. Dr. Faulkner urges veterinarians to communicate more freely with society in general in order to better influence society for the cause of veterinary medicine, veterinary research, veterinary education, and animal health in general. The Committee recommends such a constant public relations effort.

The Committee, after adoption by the Executive Board, recommends the dissemination of this report, including its recommendations to the appropriate agency officials and members of Congress.

During the past year the following new animal drug entities were approved by FDA:

Niclosamide premix—for control of mouse tapeworm infections.
REPORT OF THE COMMITTEE

Diatrizoate meglumine injection—for use in dogs and cats as an aid to radiographic delineation of internal structures, excretory urography, angiocardiography, and cystography.

Sodium oleate solution—to stimulate infiltration of cellular blood components that subsequently differentiate into fibrous and/or fibrocartilagenous tissue in horses.

Prostalene solution—an injectable to control estrus in mares.

Cambendazole—for oral administration to horses to control large and small strongyles, pinworms, threadworms, and ascarids.

Dinoprost tromethamine sterile solution—a form of prostaglandin F$_2$alpha for use in mares for its luteolytic effect in controlling the timing of estrus in cycling mares and in clinically anestrous mares that have a corpus luteum.

Naproxen—for injection or oral administration to horses for the relief of inflammation and associated pain and lameness exhibited with myositis and other soft tissue diseases of the musculoskeletal system.

Monensin—for use in cattle for increasing feed efficiency.

Lasalocid—a coccidiocide for poultry.

During the past year legislation was introduced into Congress which would divide the FDA, placing the Bureau of Veterinary Medicine and Bureau of Foods into separate agencies. Both Bureaus are involved in the review and approval of applications for new animal drugs used in food producing animals. Close liaison between these organizations is necessary for prompt and efficient review of these New Animal Drug Applications. Lack of administrative commonality may cause inordinate delays in NADA approvals, particularly if and when issues involving safety and efficacy are disputed.

The committee believes these delays would increase costs of development of new animal drugs and further stifle animal health research and development, and thereby threaten the tools of animal disease control and animal production. The agency, as now constituted, does an excellent job of assuring the safety and effectiveness of animal drugs as well as determining that harmful residues do not occur in animal tissues used for food following use of the drug as recommended.

The committee recommends that the FDA remain intact. Members of the Association should remain alert for developments in this area during the coming year and notify their Congressmen of their sentiments if related bills are reintroduced.
LABORATORY SUPPORT FOR EMERGENCY PROGRAMS
H. A. McDaniel, DVM, PhD

INTRODUCTION

Emergency Programs is a part of Veterinary Services, APHIS, USDA, with the responsibility to deal with those animal diseases requiring an emergency effort to control or eradicate to protect the livestock and poultry industries of the United States and assure the consumer of an adequate supply of animal protein at a reasonable cost. Since 1970, three national emergencies have been declared by the U.S. Secretary of Agriculture to deal with Venezuelan equine encephalomyelitis, Velogenic Viscerotropic Newcastle disease, and hog cholera.

Animal diseases which pose the greatest threat to U.S. livestock and poultry are those exotic diseases which are endemic in other parts of the world, but not found in the United States. Emergency Programs has the responsibility to deal with these diseases should they gain entry into the United States.

Laboratory support is an essential part of any animal disease eradication or control program. Many excellent diagnostic laboratories are affiliated with State Departments of Agriculture, universities, commercial organizations, and Federal agencies. Contingency plans for dealing with emergency animal diseases include utilization of laboratories in the vicinity of the outbreak and strengthening working relations between the various laboratories so personnel, equipment, supplies, and reagents can quickly be moved from other laboratories to the primary support laboratories.

Laboratory Administration During Emergencies

Veterinary Services, APHIS, USDA, in cooperation with other Federal and State agencies and universities has established five Regional Emergency Animal Disease Eradication Organizations (READEO) for the entire United States to quickly respond to emergency animal diseases. Two laboratory coordinators have been named for each READEO. Laboratory coordinators will work closely with laboratories in the vicinity of the outbreak and other sections of the READEO such as diagnosis, epidemiology, wildlife, and vaccination evaluation to quickly develop additional support required.

Specimens will be forwarded from the primary support laboratory to designated reference laboratories when additional work such as animal inoculation and comprehensive serotyping is required.

Laboratory Functions During Emergency Operations

Laboratory support will usually be required for diagnostic examinations, epidemiological surveillance and vaccination evaluation.
if vaccines are utilized. Procedures and techniques will vary according to the disease. Generally three or four producers will be conducted in the primary support laboratories. However, the volume of specimens will likely be large. Any laboratory providing primary support to an emergency operation should be prepared to process 300 to 500 specimens daily, 7 days per week.

**Diagnostic Specimens**

Techniques directly applicable to host tissues such as tissue section fluorescent antibody tests, complement fixation, demonstrations of etiologic agents or diagnostically significant lesions are most useful for confirmation of the suspected disease. In some diseases clinical signs and necropsy lesions will be adequate for the diagnosis of most cases, but laboratory support will be required when signs and lesions are not conclusive.

Speed is of utmost importance in diagnostic examinations. Depopulation of herds or flocks infected with the disease being eradicated quickly follows the diagnosis. Laboratory procedures requiring isolation and identification of the pathogen or antibody detection should not be selected as first choice techniques for diagnostic specimens. However, isolation and identification of the pathogen and/or antibody detection should be attempted on as many diagnostic specimens as possible for quality controls on the more rapid diagnostic procedure selected.

**Epidemiology Specimens**

Most of the laboratory workload will be generated from specimens collected for epidemiological surveillance. The specimens will be derived from such sources as healthy domestic and wild animals, insects, free flying birds, rodents, feed, water, and other fomites. Isolation and identification of the pathogen is often the only technique applicable to these specimens. Eradication or control can seldom be achieved without a comprehensive knowledge of the biological vectors, mechanical carrier, and reservoirs.

Qualitative and quantitative assessment of antibodies is another essential role of the laboratory. In programs where vaccines are used, antibody assessment is an essential part of vaccination evaluation. When suitable vaccines are not available, antibodies are often the most detectable tracks when the disease is not lethal.

**Training**

Personnel training is essential for any emergency effort. Field personnel need to be familiar with the laboratory procedures which have to be conducted. Frequently experimental animals can be in-
fected in the laboratory to demonstrate clinical signs, lesions, and specimen collecting, preserving, and shipping procedures.

Most of the laboratory personnel will need initial orientation concerning the total emergency effort and specific training in techniques which they will be conducting. Additional training in other techniques should be provided as soon as possible so personnel can be shifted from one area of responsibility to another as the workload increases and decreases. A sufficient number of people should be trained to conduct each procedure required so the laboratory operation will not be seriously hampered by the loss of any individual.

**Quality Control and Biological Security**

Some of the most competent personnel in the laboratory should be assigned to a unit with the overall responsibility for quality control and biological security in the laboratory. The supervisor of this unit should report directly to the laboratory director. Personnel in this unit should work closely with other personnel to detect and solve problems as fast as possible, but they should report immediately to the laboratory director when any laboratory results should be questioned. This group should also be assigned the overall responsibility to make sure the total laboratory operation is conducted in a manner that will prevent any cross contamination between specimens during processing in the laboratory and prevent escape of any viable pathogen from the laboratory.

**LABORATORY RESOURCES**

**Funds for Emergency Operations**

Since emergency animal disease outbreaks are impossible to predict, sufficient funds are seldom, if ever, available from regular State or Federal appropriations to deal with these catastrophies. Funds for emergency operations may be derived from several sources such as State or Federal contingency funds. However, during past emergencies, most of the funds were borrowed by USDA from the Commodity Credit Corporation and later repaid (with interest) from regular appropriation.

**Personnel**

Contingency planning in Emergency Programs includes training personnel to conduct laboratory procedures required for the exotic animal diseases. These people may be affiliated with Federal agencies, State organizations, or universities. The only restriction placed on personnel selected for training is an agreement with the individuals and their supervisors that will go to the laboratory serving the area of the outbreak, and remain until a replacement can be hired locally and trained or until they are no longer needed. In no case
would this commitment be for longer than 60 days; however, the individual could decide to remain for a longer period of time.

This first team of trained laboratory personnel will establish the emergency laboratory operation. Supporting personnel will be acquired locally.

**Laboratory Facilities**

Maximum utilization of existing space will receive first consideration. However, most veterinary diagnostic laboratories do not have adequate space for their normal operations. Additional space will usually be required for emergency operations.

Trailers can be rented in most cities throughout the United States. These units can be readily equipped for most laboratory operations except large animal necropsy.

Biological security may be easier to achieve in trailer laboratories than permanent structures, if only one operation is allowed in each trailer. Facilities for entry-exit showers and change of clothes can readily be installed in trailers. The space between trailers is a barrier to the spread of infectious agents.

Space for parking trailers that are to be used as laboratories may present a problem since most trailer parks are restricted by zoning regulations to only residential use. Land owned by local, State, and Federal governments and especially military bases should be investigated. Access to telephone, electricity, sewer, and water service are primary factors in site selection.

**Equipment**

Most veterinary diagnostic laboratories are well equipped for normal operations. However, the increased workload during emergency operations will likely necessitate acquisition of additional equipment. Most laboratory equipment required during emergency operations can be readily purchased. Items requiring more than two weeks for delivery or which require special construction or modification will be purchased or constructed and held for emergency use.

**Reagents**

Diagnostic reagents required during outbreaks of exotic animal diseases present special problems. Many of these reagents consist of viable pathogens. Antiserum for serum neutralization testing, preparation of conjugates, use in agar gel diffusion and other procedures, requires weeks or months to produce. Therefore, part of the contingency planning will be devoted to selection of laboratory
procedures to be used for each disease and production, storage, and periodic testing of the reagents required.

DISCUSSION

As the emergency operation progresses, the laboratory role changes. Initially, diagnostic examinations constitute the greatest share of the workload. As the disease is brought under control the number of diagnostic examinations will be reduced, but the number of epidemiological surveillance specimens will increase. The field forces will be concentrating on detecting reservoirs and vectors of the pathogen such as wildlife, free flying birds, insects, rodents, and fomites. The competency of the field diagnosticians should increase so more diagnoses can be made without laboratory assistance.

Antibody surveillance activities will increase as the program progresses. Qualitative and quantitative antibody determinations are needed for epidemiological surveillance and vaccination evaluation.

SUMMARY

Laboratory support for emergency animal disease control and eradication programs will utilize existing laboratory facilities and personnel to the maximum extent possible. The diagnostic laboratory which normally serves the area where the disease occurs will be expanded to meet the needs of the emergency effort.
GUIDELINES FOR INDEMNIFICATION UNDER DISEASE ERADICATION PROGRAMS WITH SPECIAL EMPHASIS ON FOOT-AND-MOUTH DISEASE: A SUMMARY REPORT

Nasser A. Aulaqi, PhD and W. B. Sundquist, PhD

1. Introduction

A primary objective of the federal indemnification program for livestock and poultry (Section 2d. of PL87-S-18, 87th Congress, effective July 2, 1962) is to promote successful control and eradication of exotic animal diseases if and when such diseases are introduced to the United States by establishing indemnity payments to producers that are adequate and fair. Evidence has shown that payment of fair and adequate indemnities encourages the cooperation of producers in the control and eradication of animal diseases.

During the Newcastle disease outbreak in California in 1972-73, considerable time, effort and money were devoted to determining acceptable and fair indemnities for condemned poultry flocks which were destroyed under the Newcastle eradication program. With this in mind, the Animal and Plant Health Inspection Service (APHIS) of the USDA contracted with the University of Minnesota to conduct a general study of the economic impact of foreign animal diseases with special emphasis on foot-and-mouth disease. The development of guidelines to provide equitable indemnities for depopulated livestock was among the several objectives of the research contract. This paper is a summary of the research report on indemnity guidelines. The whole report can be obtained from the authors.

2. Financing of Indemnity Payments

Because of the externalities involved in the benefits and costs

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2Research Associate and Professor, respectively, Department of Agricultural and Applied Economics, University of Minnesota. The report on which this paper is based is part of a collaborative study on the economic impact of foot-and-mouth disease in the United States by the Department of Agricultural and Applied Economics and the College of Veterinary Medicine, University of Minnesota, under a contract from APHIS. Dr. Hunt McCauley of the College of Veterinary Medicine is co-principal investigator. Dr. E. C. Sharman of APHIS is the project coordinator.
3To illustrate the externality concept let us assume that a farmer decides to control FMD by himself in the absence of government intervention to control the disease. Such action by the farmer will confer an external benefit to his neighbors in the form of reduced hazard of getting the disease. The farmer will not, however, receive a reward for protecting his neighbors. On the other hand, a farmer’s failure to control FMD on his farm will impose additional costs on his neighbors. Thus, in the absence of government intervention there is a divergence between social and private costs.
of FMD control programs, governments in many countries, particularly those which use a slaughter policy, have seen fit to intervene on behalf of producers and consumers alike to control such diseases. Moreover, countries which use the policy of eradication have typically paid for all control and eradication measures including indemnities to producers whose stock or products were destroyed.

2.1 Bases for Public Financing

The United States has in the past, used the most stringent measures to combat FMD epidemics. These measures included direct slaughter of affected and exposed livestock. The use of such measures in the future will surely entail compensation for producers. And, such compensation is well established in precedent and in legislation.

Another objective rationale for justifying indemnity payments is that of protecting the entire livestock industry, related industries and consumers from severe economic consequences which would result if financial incentives were not available for the livestock sector to restock and rebuild following the destruction of basic breeding herds and inventories of livestock and livestock products. And, because both the supply and demand for livestock products are relatively inelastic, the major portion of benefits from FMD control will normally be passed on to consumers in the form of lower retail prices. A preliminary study by Aulaqi has estimated on a gross basis, that a nationwide epidemic of FMD in the U.S. could increase meat expenditures by U.S. consumers by an amount in excess of $3.4 billion in the first year.4

2.2 Extent of Indemnity Coverage

We have reviewed indemnity legislation in many countries of the world and we came to the conclusion that the United States has one of the most comprehensive and generous indemnity payment programs. For example, the cost of cleaning and disinfection of infected and exposed premises is borne by the U.S. government but in many countries the cost is at least partially borne by the farmers. The reader is referred to Appendix A for further details on indemnification procedures in other countries.

The issue of extending coverage to secondary or consequential losses has been discussed. Some people argue that indemnity payments should be extended to cover consequential losses. We have found that it is very difficult, if not impossible, to clearly define and quantify all of these losses and the classes of people who may

claim them. Moreover, the overall impact of consequential losses is not unlike those resulting from fluctuations in the volume of livestock and livestock products due to weather, high feed prices, etc. And, consequential losses of the latter type are not indemnified.

While we believe that direct indemnity payments should be limited to those whose livestock and/or other products are destroyed as part of the eradication program, we recognize that other producers and firms may suffer real economic losses for which they may be entitled to some form of compensation. It is our suggestion that in cases where consequential losses represent severe economic hardships, those hardships should be alleviated via utilization of such policies as low cost loans, liberal tax writeoffs, special unemployment compensation authorization, etc. Such policies, while recognizing the existence of economic hardship and the need for assistance, do not require quantification of nebulous consequential impacts.

3. Appraisal Methods

Three methods may be used in determining values for indemnification purposes. These are:

1. Current market value
2. Cost of production and
3. Flat rate

The market value method is the most efficient and fair of the three methods. It is suggested that this method should remain the basis for paying indemnities for all classes and species of livestock. There are, however, certain situations where the open market price method as such cannot be used. For example, if a major disease epidemic is involved, the use of the current price as defined in the code of Federal Regulations (part 53, Title 9) may not be feasible because of the closure of livestock markets and, therefore, the elimination of any readily ascertainable market in which prices can be measured. A proposed method for evaluating livestock under epidemics which necessitate the closure of markets for long periods of time is described in Appendix B.

4. Procedures and Guidelines for Appraising Livestock

In order to develop an equitable and efficient appraisal system of livestock conforming to that required by law, it is necessary to follow some systematic and uniform method of evaluation that considers quality, yield and other differences of livestock species. A major section of our report describes in detail procedures for determining equitable and uniform indemnity payments for all major species and classes of domestic livestock susceptible to FMD. We suggest that APHIS should give serious consideration to those pro-
c edures for possible use in future eradication programs, particularly, the section on appraising dairy and breeding animals which contains valuable reference material and broad guidelines and procedures for evaluating commercial and purebred animals.

Relevant and accurate data is a necessary requirement for a successful and fair indemnification program. Reasonably accurate and adequate data is provided by the Federal-State Market News Service on feeder and slaughter livestock. This type of data can be obtained directly by appraisers. Prices for varying grades, qualities and weights can be established at almost any time for almost any area in the United States.

In contrast to feeder and slaughter livestock, price data on breeding and dairy animals is very scanty. There are no regularly established markets such as terminal markets with regular price quotations for breeding and dairy stock.

Because of the lack of adequate and current price data for breeding and dairy animals we propose that APHIS establish, in cooperation with SRS, FSMNS and other USDA agencies a data reporting system on livestock prices at the local, state, regional and national levels. The proposed system should be used only to collect data not currently available. For example, market reporters employed by FSMNS may expand their activities to include price reporting on breeding animals and dairy cattle. We suggest that data expansion should be planned in advance but that it need only to be implemented during disease outbreaks. In conjunction with this expansion in data acquisition it is recommended that appropriate USDA agencies be assigned the task of establishing a set of formulae which provide estimates of historical relationships between subsets of animals within different classes of breeding stock (e.g. Table II in the report) and of other useful prediction equations (e.g. dairy cow prices, beef prices and milk prices, Table 4 in the report) with appropriate adjustment factors for seasonal and locational variations.

5. Concluding Recommendations

We conclude that the use of the open market value for livestock and products at the time of slaughter is the only practical approach to indemnification. If the situation develops in which all major markets are closed and there ceases to be any reliable yardstick on which to base indemnity values we propose that historic prices be used and that they be adjusted to reflect changing seasonal, cyclical and other price movements.

It is suggested that professional appraisers be used for valuation

*We are not passing judgment on the importance (or lack of importance) of these data for purposes other than indemnification for disease control purposes.
of livestock, particularly in the case of registered animals. APHIS should establish a list of appraisers chosen with consultation with the respective breed associations. During emergency disease eradication programs appraisers may be chosen from these lists to appraise registered animals.

In order to maintain a degree of uniformity in the valuation of livestock it is suggested that the appraisal officers attached to the Regional Emergency Animal Disease Eradication Organizations (READEO) be given the responsibility of monitoring indemnity payments in their assigned regions.

Full compensation through indemnity payments should be limited to payments for animals, animal products or materials directly destroyed in the operation of a disease eradication program. While it is recognized that consequential losses may prove to be substantial it is suggested that direct payment of indemnities should not be made for such losses. Rather it is recommended that in those cases where consequential losses represent severe economic hardships, those hardships should be alleviated via utilization of such policies as low cost loans, liberal tax writeoffs, unemployment compensation, etc.

APPENDIX A. A Summary of Compensation Provisions in Selected Countries

1. Federal Republic of Germany: Compensation is authorized under an epizootics act which provides for compensation on the basis of the full market value. Compensation payments are financed by an epizootic fund which receives an annual contribution from all the owners (per head of animals) and also receives a state subsidy.

Coverage: Compensation covers only slaughtered animals. Loss of income is not compensated. Furthermore, compensation does not cover cattle imported into federal territory within a fixed period of time before the incidence of the disease, unless it has been proven that the animals contracted the disease after import. The right to compensation may be lost if the owner fails to notify the authorities about the appearance of the disease in his premises within 24 hours or knowingly bought an animal or animals affected by the epizootic.

2. France: Livestock owners whose animals are destroyed may obtain compensation payments. The amount is fixed by ministerial order or by decree according to the disease. Animals affected by FMD are compensated at 100 percent of market value if vaccinated and 75 percent of market value if not vacc-
cinated. No compensation is made for consequential losses.
A producer who finds the estimated compensation payment to be low may contest it before the Perfect. In reality, complaints are very rare because compensation is made by experts proposed by producers themselves.

3. **Greece:** The minister of agriculture appoints a commission to assess the market value of the animals which is fully compensated by the government. The decision of assessment of the value of the slaughtered animals is irrevocable.

4. **Netherlands:** Compensation is paid in full for animals suspected of having the disease and only 75% of market value is paid for infected animals. Loss of profits is not compensated.

5. **Poland:** Compensation for slaughtered animals is 100% of the estimated market value, and 75% for dead animals. The value is based on the value of the healthy animals, according to current prices in the local market. There is no scale which fixes it in advance. The estimated value takes account of the particular characteristics of the animal, such as milk productivity, pedigree, etc.

6. **Sweden:** Compensation is made according to the market value the animal would represent if the disease had not occurred. Claims owing to loss of earnings may be compensated within certain limits. The maximum payment is equivalent to the amount paid under the Swedish provisions for health insurance to individuals as compensation for lost earnings in cases of sickness.

7. **Britain:** Compensation is for full market value. No compensation is paid for any consequential loss caused by eradication procedures such as the loss of profits to producers whose animals are slaughtered. There is accordingly no compensation for any loss ensuing from restrictions on movement of animals. Slaughtered animals are valued individually and not as a herd.

**APPENDIX B. Evaluation of Livestock When Livestock Markets are Closed**

Under ordinary situations where only minor epidemics of FMD or other exotic diseases occur the method of appraisal discussed in this paper is adequate for determining fair indemnity values. However, when a major epidemic occurs which extends to major livestock production areas of the country and remains for a long period of time (more than two months), the use of the current market price as a basis for indemnification may not be feasible simply because of closure of livestock markets which eliminates any readily ascertainable yardstick against which prices could be measured.

It is possible that the situation described above may never occur
in the United States but at the same time we need to be able to deal with such a situation if it ever arises by having built-in flexibility in the indemnification guidelines.

The following procedure is suggested for use in determining indemnities when widespread and prolonged outbreaks of disease occur:

1. A base price should be established for each class of livestock covered by indemnity legislation. The base price may be the market price prevailing prior to the closure of livestock markets.

2. Producers of breeding and dairy animals whose stock is destroyed should be paid indemnities on the basis of the established base price with the understanding that adjustments will be made later to reflect the changing price conditions during the outbreak period.

3. When normal trading in livestock is resumed, APHIS should appoint a panel of livestock marketing specialists whose major responsibility is to oversee the supplementary payment program.\(^a\) The panel may determine supplementary payments on the basis of the changes in prices for different classes of livestock. In general the amount of the supplementary payment should be the difference between the base price and the replacement cost for similar (like) animals.

It is suggested that supplementary payments be limited to owners of breeding and dairy animals and specifically to only those who restock their farms. The justification for supplementary payment to owners of breeding and dairy stock is that such payments will help bring the basic inventory of animals to normal levels and, therefore, minimize the future economic impact on producers and consumers alike.

It is obvious that there is a need for further evaluation of the procedure suggested above for appraising livestock under major disease epidemics. It is intended only as an illustration and further detail will be needed to make it applicable. However, we recommend that APHIS give serious consideration to such a proposal.

\(^a\)The panel may include purebred and commercial producers, dealers, livestock marketing economist, livestock appraisers, etc.
It has been my experience that every 5 years we consider what we would do if a devastating animal or poultry disease outbreak occurred in this country. We get concerned for a few days and then forget all about the problem for another 5 years. We cannot continue to be indifferent to this serious threat to our livestock and poultry industry. Thus the challenge must be accepted by the livestock and poultry industry and related industries as well as the veterinary profession. Let's look at the background, history, and general information about disease eradication.

It was the belief of the people in the ancient periods of our civilization that epidemics and even endemic diseases were sent by their gods as punishment for the sins of man. Since man is willful, wanton, and sinful by nature there was never any difficulty in finding a particular set of sins to justify a specific epidemic. By 430 B.C. the Greeks had concluded that certain plagues were contagious. Man was slow to accept and put into application learned facts about diseases. Almost 150 years passed after the discovery of bacteria and protozoa before any definite application of this new knowledge was made in the study of the cause of diseases. Almost 100 years passed between the period of Jenner’s cowpox investigations and the establishment of an effective foundation of the science of immunology by Pasteur. In 1843, animal diseases were a minor problem in the United States. Even after the colonization of America, native livestock was free of many of the diseases that trouble us today. Livestock later imported from Europe brought diseases with them. Some of these diseases still plague our livestock and poultry industry.

The slow boats which brought the animals here from Europe served as a floating quarantine. Because of this factor at that time, certain diseases from Europe were prevented from being introduced into this country. Further, the lack of transportation in the United States at that time also limited the spread of diseases to our livestock. As our country and the livestock population grew and our mode of transportation improved, our livestock disease problem grew in proportion.

To elaborate this point, the following examples illustrate the importance of animal diseases to man’s well-being and to what extent diseases were spread when animals were shipped in channels of trade.

Hog Cholera first appeared in the United States about 1833 in the Ohio Valley. It did not become widespread for 20-30 years because swine did not go far from home.

The first outbreak of foot-and-mouth disease occurred along our northern border in the winter of 1870. Because animals and people
did not move freely in cold weather, the disease spread very little and died out before spring.

Rinderpest outbreaks occurred in Russia, Poland, and Greece following the invasions of these countries by the various armies during the first World War. This disease caused enormous losses of livestock and played a part in the post-war Russian famine that cost thousands of lives.

Today African Swine Fever is a very serious threat to our swine industry. This disease has killed an estimated 4 million swine in Europe since emerging from Africa in 1957. Further, it has moved to within ninety miles of the United States where it resulted in the death of over 400,000 animals in Cuba in 1971. There is no vaccine available for use against this highly fatal disease.

Some other diseases that are a serious threat to this country are:
- African Horse Sickness
- Foot-and-Mouth Disease
- East Coast Fever
- Fowl Plague
- Lumpy Skin Disease
- Rift Valley Fever
- Rinderpest

World food production is presently inadequate—two-thirds of the world's children suffer from malnutrition. World food production now falls nearly 2% behind requirements every year.

The United States is one of only 10 countries with a significant surplus of food. Those 10 countries contain only 15% of the world's population.

While disease and parasites limit livestock production in the United States by an estimated 11%, countries faced with exotic diseases and inadequate veterinary service frequently lose 30-50% of potential livestock production.

Control of animal diseases is essential to the improvement of the world's food supply, the economy of the developing countries and world peace.

Should a devastating contagious or infectious disease be introduced into this country by livestock or poultry that have been in channels of trade, a prompt diagnosis is essential in order that a disease eradication program may be initiated immediately.

The livestock or flock owner in this situation is the key. The prompt reporting of any illness in newly acquired livestock by the owner to his attending veterinarian is essential. The attending veterinarian in turn would report the disease situation to a State or Federal regulatory veterinarian.

In Virginia, if a veterinarian, extension agent or a herd owner reports a possible disease outbreak in a county or area of the state, the Code of Virginia states the following:

"It shall be the duty of the State Veterinarian at any time, upon
receipt of reliable information of the existence among domestic ani-
mals or poultry of the State of any infectious or contagious disease,
to go at once, or order an assistant veterinarian to go, to the place
where such disease is alleged to exist for the purpose of making a
careful examination of the animals or poultry believed to be affected
with such disease, and ascertain, if possible, what, if any, disease
exists, and whether the same is contagious or infectious. If a disease
is found to be contagious or infectious, the State Veterinarian, or an
assistant, may adopt and enforce such quarantine lines and regula-
tions and shall enforce such cleaning and disinfection of premises,
cars or vehicles, as may be deemed necessary to prevent the spread
of such disease.” From this mandate, it is quite evident that our
legislators realized the importance of prompt disease reporting.

For several years it has been the policy of our regulatory vet-
erinarians to visit and inspect animals or poultry shipped to our
state from foreign countries. Upon our visit we stress the importance
to the owner of notifying his veterinarian or a State-Federal vet-
erinarian immediately if such animals or poultry became ill. We feel
that once a devastating disease is known and reported, eradication
procedures can be initiated immediately. Such action would be
initiated by the isolating and quarantining of infected herds or flocks
and placing embargoes on the movement of animals, poultry, exotic
wild animals or birds.

Some other contributing factors that must be taken in account in
disease eradication are migratory animals and birds, wind and sea
currents. Inapparent carriers and usual hosts can also play a part in
the spread of animal and poultry diseases.

Some of the important tools needed for disease eradication are:

1. Record keeping by dealers. We need to know as rapidly as possible
   the origin and distribution of exposed animals or poultry.

2. Spot checking intra-interstate movements of livestock and poultry
to determine if health regulations are being complied with and to
   maintain a knowledge of the trade channels and routes through
   which livestock and poultry are shipped within a state or states.

3. State animal welfare regulations or laws. Again, the origin and
distribution of sick exposed animals or birds are a vital key in a
disease eradication program.

4. Weekly inspection by State-Federal personnel of each livestock
   market within the state.

5. Morbidity reporting by the practicing veterinarian.

6. The availability of well trained diagnosticians, livestock inspec-
tors, laboratory personnel and epidemiologists.

7. State laws for quarantining, issuing hold orders, and the right of
   entry.

8. Close working relationship with wildlife people, military and ex-
tension personnel, industry leaders and practicing veterinarians.
The following factors would have to be determined before an emergency could be declared.

1. Confirmation of the diagnosis to be certain of the disease that must be combated; evaluation of its potential effect on the industry affected and the approximate cost to eradicate such a disease.
2. The source of the disease and when it was introduced into the state.
3. The exact geographic distribution of the cases of the disease.
4. The method of spread, such as herd or flock additions, contaminated feeds, insect or parasite transmission, etc.
5. Thorough understanding of the characteristics of the disease organism, together with a knowledge of the species, age and sex of animals that can be affected.
6. Recognition and consideration of the relationship of insects, wild animals, or birds, rodents, etc., to the transmission of the animal or poultry disease.

The previous discussion has been about the history of disease eradication. Now let's look at the type of organization Virginia has developed to work with APHIS-READEO (Regional Emergency Animal Disease Eradication Organization). In Virginia we are most fortunate to have six (6) regional laboratories with State-Federal personnel assigned to each laboratory. Thus we can establish headquarters in most of the major areas of the state if needed and divide the workload that must be accomplished. We are establishing in our Division a group consisting of veterinarians, laboratory, dairy and meat inspection personnel, and livestock inspectors, who will be assigned to an emergency animal and poultry disease awareness program. Also assigned to this unit will be representatives from the Extension Service, the Division of Game and Inland Fisheries, practicing veterinarians, and the military.

Our emergency disease awareness organization will be guided by an Assistant Director of Emergency Diseases, who will work under the direction of the State Veterinarian and APHIS-READEO Director.

Under the Assistant Director there will be three sections. First, an Advisory Staff, consisting of representatives from the Extension Service, military, wildlife, pet dealers, and practicing veterinarians. The second group, the Service Staff will consist of representatives of the Division's laboratories, Dairy Inspection Service and Meat Inspection Service. The third group, the Technical Support Staff, will be composed of representatives of APHIS and our Division veterinarians.

The Organization Chart is on the next page and is followed by a description of the duties of each group.
Each chairman is responsible for the overall functions and assignments in his section as designated by the Assistant Director.
Assistant Director(s) (State): 1. Acts for the READEO Director in his absence. 2. Is liaison officer between READEO and State officials in the state involved. 3. Moves to the headquarters of the READEO immediately when the outbreak occurs. 4. Maintains information regarding personnel, equipment, and finances available from State sources for use in eradicating emergency animal diseases. 5. Is knowledgeable concerning State authorities, regulations and accepted procedures pertaining to READEO activities.

Advisory Staff: 1. Maintain list of the name, address and location of livestock and poultry owners in each county. 2. Maintain list of exotic bird breeders in the state. 3. Devise a plan for preventing the introduction of infection on farms or in communities. 4. Determine availability of military manpower and equipment. 5. Develop procedures to establish and carry out wildlife policies and objectives as they would relate to Emergency Disease Awareness Program. 6. For public information, develop ideas for mass media presentation and for small target groups. 7. Establish procedures for reporting and dissemination of information through the practicing veterinarians.

Service Staff: 1. Determine laboratory capabilities and location of commercial laboratories in the state. 2. Maintain list of Grade A and manufacturing milk producers in the state. 3. Establish procedures at slaughter plants if infected or exposed animals are slaughtered.

Technical Support Staff: 1. Ascertain availability of heavy equipment, office supplies, etc., in each county. 2. Determine movement patterns of livestock after sale at a livestock market and buyers at each livestock market. 3. Develop procedures and teaching aids for training of new employees. 4. Devise a permit system for movement of animals or birds from non-quarantined areas. 5. Forecast area of expected movement of disease. 6. Develop alternate methods for gross handling of carcasses and wastes.

I think it is quite evident that this type of awareness program, to be successful, requires the cooperation of many agencies and individuals. Also, we need to have at our finger tips current information about the livestock and poultry industry and its various related segments.

Our goal in our Virginia READEO organization is to meet once or twice a year with all members of the task force. In such meetings our agenda will include the following topics:

1. Updating of foreign animal and poultry diseases with respect to the incidence, the latest tests, countries that the disease exists in, current eradication procedures, etc.
2. Establishing and updating organization and group responsibilities and functions.

3. Updating and reviewing of pertinent state data and information, such as list of pet shops and dealers, earth-moving equipment, wildlife stations, private laboratories, etc.

4. Reviewing of task force functions with APHIS-USDA Emergency Disease Staff.

5. Briefing from representatives from wildlife, pet dealers, and the military in regards to the activities in their programs that could affect Virginia's Emergency Disease Awareness Program.

6. Conducting simulated test exercises to assist in developing a realistic and efficient organization.

We feel that these efforts will assist us in maintaining an active Emergency Disease Awareness Program at all times.

In conclusion, I think the challenge in emergency disease awareness programming is keeping everyone continuously concerned and motivated during the periods when there is a lack of a challenge.
REPORT OF THE COMMITTEE ON
EPIZOOTIC ATTACK PLANS

Chairman: H. Q. Sibley, Austin, TX


The Epizootic Attack Plans Committee met on November 11, 1976. Forty-two members and guests were present.

Dr. Harry W. Kinne, District Veterinarian, USDA, Laredo, Texas presented a most informative and alarming report on Tick surveillance on the Rio Grande River. Not only fever ticks, but also the causitive agent of bovine piroplasmosis has been involved in at least two outbreaks in recent years.

The permanent quarantine zone along the Rio Grande River effectively prevented fever ticks in Mexico from invading the United States since eradication was declared in 1945 until 1968, when the first major outbreak occurred. Subsequently, several outbreaks have occurred. In 1972 bovine piroplasmosis killed 8 cattle and was also found during the fever tick outbreak in 1973.

The southern Texas environment has become increasingly favorable for reproduction, survival, and spread of fever ticks. Buffel grass was introduced and thrived, and rainfall increased. Improved pastures resulted in tripling the livestock population. Instead of having to struggle for survival in a hot dry and barren environment, fever ticks now thrive in warm moist surroundings heavily populated with livestock. There are likely many areas infested with fever ticks that have not yet been found. A good surveillance program is desperately needed. Fever ticks pose a severe threat to Texas and the entire United States.

Dr. Stan Flora, Veterinary Services, reviewed a bird smuggling case in Texas which vividly demonstrated conflicts in the United States Code between Public Law 87-518 and the Lacey Act. Conflict also exists between USDA responsibility to protect the health of the U.S. domestic animal population and the responsibility of the U. S. Fish and Wildlife Service to preserve members of a wild species. The conflicts arose when 326 parrots with an estimated value of $50,000 were seized by the U. S. Treasury Special Agents after being smuggled into Texas from Mexico. The parrots were initially retained at a USDA Facility. Veterinary Services requested custody of the parrots so that they could be destroyed. The birds were being confined in small cages, were suffering from stress, dehydration, starva-
tion and several were dead. The U. S. Attorney requested the birds be kept alive as evidence. U. S. Customs Investigation Service and the U. S. Fish and Wildlife Service made arrangements for the birds to be placed in a bird quarantine facility. Twenty-seven days later the birds were exhibiting disease signs including nasal and ocular discharge, pasted vents, leg and wing paralysis, torticollis, and numerous deaths. Thirty-three days following seizure and after Mexico refused to allow the birds to enter Mexico, custody of the birds was given to Veterinary Services and they were immediately destroyed. Subsequently laboratory studies confirmed that the birds were infected with viscerotrophic Velogenic Newcastle Disease which had recently been eradicated from southern California at the cost of $56 million.

Dr. John Osborne, Jr., Laboratory Director, San Gabriel, California described and illustrated with vivid photograph outbreaks of Malignant Catarrhal Fever (MCF) in two dairy herds near Chino, California and in the San Diego area. In one dairy herd over 120 cattle were lost. Clinical signs, antemortem and postmortem lesions, and histopathological changes were typical of MCF. The most recent case occurred in mid October, 1976. The disease was transmitted to a yearling by intraperitoneal inoculations of several hundred milliliters of whole blood quickly after collections from an affected cow. Specimens were submitted to Plum Island Animal Disease Center from several cows, but no agent was isolated in spite of extensive efforts including animal inoculations.

The causative agent of the African form of MCF is extremely fragile, usually destroyed by freezing, and survive under refrigeration only a few hours. No agent capable of causing the typical disease has been isolated from MCF cases in the United States.

Dr. Saul T. Wilson, Assistant Regional Director, USDA, reported on actions taken to eradicate recent outbreaks of hog cholera in New Jersey and New England. Epidemiological investigations indicate the use of viable hog cholera vaccine was the cause of the outbreaks. The last case was in July 1976. High level surveillance will continue for at least one year after the last case.

Dr. E. Hunt McCauley reviewed data presented last year from the USDA/University of Minnesota Study on the Economic Impact of Foot and Mouth Disease (FMD) in the United States, and new data developed during the current year. The final report with all appendices should be ready for publication by the summer of 1977.

The objectives of the study are:

1. Estimate the economic impact should FMD become endemic in the United States.
2. Determine the economic consequences of alternative control strategies.

3. Provide guidelines for indemnification policies.

The following points were discussed.

1. Studies of European experience with FMD indicate that endemic FMD with voluntary control measures results in an average of 4.26% of herds infected annually. If compulsory vaccination and control is practiced the average infection rate is below 0.05%.

2. The cost of vaccinating animals in the United States is estimated to be $5.88 per head. Transportation, refrigeration, storage and other related costs were included in the estimate.

3. Should FMD be allowed to spread throughout the United States without controls, the direct cost the first year are conservatively estimated to be 3.6 billion dollars. Indirect cost could multiply this figure 2 to 3 times.

Several sub studies to develop additional data are being conducted including 1) Production Losses, 2) Large feedlot and dairy production areas, 3) Guidelines for Indemnification 4) Movement of Milk, 5) Operational cost of an FMD Eradication program, 6) Social cost and benefits of FMD control, 7) Animal Movement, and 8) Epidemic Planning using computer systems.

The Committee forwarded 5 resolutions to the resolutions committee on: (1) interstate movement of swine fed raw garbage, (2) processing food waste, (3) declarations of a national emergency to deal with Boophilus ticks in Texas, (4) Illegal importation of birds and animals, and (5) Malignant Catarrhal Fever.

The Committee recommends 3 manuscripts for publication in the proceedings: (1) State plans for Emergency Diseases by Dr. A. J. Roth, (2) Laboratory support for Emergency Programs by Dr. H. A. McDaniel and (3) Guidelines for Indemnification under Disease eradication programs with special emphasis on Foot and Mouth Disease by Nasser A. Aulagi and W. B. Sundquist.
SALMONELLOSIS: ANIMAL-HUMAN ENVIRONMENTAL IMPACT

Stanley L. Diesch,* DMV, MPH

Historical

On March 11-13, 1964, a National Conference on Salmonellosis was held at CDC in Atlanta, Georgia. The purpose of this Conference was for the interchange of ideas in order to open channels of communication necessary for the development of a successful salmonella control program. In summarizing the conference, Dr. A. Langmuir, offered a few general principles:

1. We must have better reporting.

2. Urge state health authorities to re-examine their regulations and modernize their procedure for detection and management of carriers.

3. Serious efforts must be made to eliminate Salmonella from foods and feeds.

4. More cooperation in international surveillance is desirable. He concluded that sooner rather than later, a major reduction in the amount of salmonellosis in the United States would be achieved.

In June, 1967, at the request of the FDA and USDA, the National Academy of Science conducted an in depth study of the salmonellae problem. As a result of that thorough study, the Academy concluded that it was unreasonable to expect the eradication of salmonellosis in the foreseeable future, but much could be done to reduce the presence of pathogens in the food supply and minimize the likelihood of infection.

For six years (1966-1972), the USDA and FDA had functioned and taken positive action under a memorandum of understanding in a Cooperative State-Federal Salmonella Program for animal and marine protein industries. Due to limitations in funds and personnel ceilings, on June 30, 1972, Veterinary Services of APHIS discontinued the program.

In 1972, Drs. Walker, Pfow and Allred presented “The Status of the Cooperative State-Federal Salmonellae Program”, at the USAHA meeting here in Florida. This was the final report. The USDA discontinued its support of this with the exception of salmonellae serotyping reference assistance. This Program had been designed to pre-

*Professor, Department of Large Animal Clinical Sciences, College of Veterinary Medicine (St. Paul Campus); and Professor of Epidemiology, School of Public Health, Minneapolis Campus, University of Minnesota.
vent or at least reduce *Salmonella* contamination in feed supplements of animal and marine origin while working to eliminate the pathogen from these two ingredients of livestock and poultry feeds. To measure progress, the program was conducted on an individual plant basis in the following three phases: Phase I "Evaluation", Phase II "Cleanup" and Phase III "Approved". The final report indicates that progress was made. In 1972 inspections and tests, there were 26 plants in Phase I "Evaluation", 519 plants in Phase II "Cleanup", and 196 plants in Phase III "Approved". The authors concluded that these data, though not dramatic, are encouraging and do reflect progress for industry and cooperating agencies, even though the Program had received a low priority.

In absence of federal support, states and rendering industries were left to continue or drop the program. Some states and individual industries have attempted to continue, however, without a coordinated National effort, progress in the program was extremely difficult.

A Minnesota renderer who had been a participant in the Cooperative State-Federal Program indicated this summer that the salmonellosis control program was the best thing that ever happened to the industry. This effort served to improve the quality of their rendered products. In cooperation with a State Laboratory this particular renderer continues to test the finished product for salmonellae but he may be the exception.

In 1973, the FDA, Bureau of Veterinary Medicine pursued a Voluntary Cooperative Federal-State-Industry *Salmonella* Program for animal and marine by-products, and conducted a field survey of the blending plants of rendered animal and marine by-products.

To meet and develop a Voluntary Cooperative *Salmonella* Program, a Bureau of Veterinary Medicine Working Committee was formed with State-Federal Agency Representatives of USDA, FDA and Department of Commerce, and comparable State Agencies. Subsequently, the FDA Commissioner decided that an Operation Research Study was necessary to reassess implementation of the Cooperative *Salmonella* Control Program in order to determine whether resources necessary, are commensurate with benefits gained.

On February 14, 1976, the FDA Commissioner accepted the three recommendations of the Task Force, found in the position paper, resulting from the *Salmonella* Operations Research Study. These recommendations are: 1) the FDA not initiate any new federal regulatory program aimed at the animal and marine by-products industry, with the exception of those individual cases exhibiting a clear and present danger to public health, 2) discontinue the detention of imported rendered products in order to be consistent with the recommendations found in the position paper concerning domestic products, 3) FDA is proceeding to vacate all injunctions against
SALMONELLOSIS

domestic rendering plants and their products, since the current posture of the agency does not support the continuation of these injunctions. This action extensively reduced the efforts of the Federal government in a coordinated control program for salmonellosis.

Present

The fact remains that the disease in the U.S. is a significant and extensive public health problem. It continues to exist as the major zoonotic disease. Each year more than 20,000 human cases are reported with estimates that close to 2 million actually occur.

In the period of 1968-1974, the serotypes most frequently isolated from human and non-human sources varied little from those isolated in 1963-1967. *S. typhimurium* accounted for 26.5% from human sources and 20.7% from non-human sources. *S. enteriditis, S. newport, S. heidelberg, S. infantis* and *S. saint paul* were also commonly isolated. No particular vehicle of transmission appeared to be responsible for the large number of infections caused by the above serotypes. The similarity of isolates from human and non-human sources emphasize the role that non-human reservoirs and sources play in human disease.

Research

The extensive health problems that this disease causes in animals and humans through their common environment are documented in the literature.

Dr. Erskine Morse and Associates of Purdue University and other researchers have extensively documented the continued economic and public health problem associated with salmonellosis in horses, cattle, swine, dogs, fish, humans and the environment. Dr. Morse states that salmonellosis ranks as the most common and economically destructive zoonosis.

Salmonellosis represents a definitive public health, and an economic problem which is costly to the total food chain from the producer to the consumer. The economic cost of the effects on human health appears to be extensive. One can not put a cost figure on human mortality which occurs with greatest frequency in the young and old. In 1974, 59 human deaths in the U.S. were reported from salmonellosis. Salmonella is a contributing factor in other terminal illnesses and may not be reported. The number of human cases reported in 1975 declined. CDC officials contribute the decline in reported salmonella isolates to diminished activities of reporting centers. In particular, budgetary restraints experienced by reference laboratories have led to a curtailment of serotyping efforts.

The economics has been documented in the Middleton Outbreak
which occurred in Minnesota, in 1973, when 125 cases of foodborne salmonellosis resulted from cross contaminated food items served at a picnic and a smorgasbord. Food specific attack rates implicated potato salad and chicken dressing as vehicles of transmission. Both were likely contaminated when prepared in pans that shortly before contained uncooked chicken pieces suspected to have harboured salmonellae. Chickens were traced to 3 farms where feed samples were found to contain Salmonella. The economic impact of this foodborne salmonellosis outbreak was described by Levy and McEntire, the cost of this outbreak which affected 125 individuals was estimated at $28,733. The largest cost was in lost salaries and productivity of ill wage earners, totaling $18,413. Costs for medical care and health department's investigation of the epidemic, and the financial burden of the owner of the implicated restaurant accounted for the remainder of the economic consequences. The projected cost per individual case is $230. Because of inflation this is underestimated for 1976. Further projection of the possible economics of the 23,445 cases reported in 1975, is nearly $5.4 million. If two million human cases occur, this cost is estimated at $460,000,000.

Economic figures have been estimated for the cost in animals. Morse indicates that this may range from $30 million to $120 million per year.

Further evidence of the magnitude of the problem is the waterborne epidemic which occurred in Riverside, California, in 1965, where a total of > 16,000 cases occurred, at least 70 were hospitalized and 3 died. S. typhimurium contaminated municipal water supply was associated with the epidemic.

Dubbert, at the 1975 USAHA meeting stated that salmonella contamination and infection of U.S. meat and poultry products begins with breeding flocks and herds, then continues in rearing areas where endemic infections spread from one animal to another. He stresses the importance of contaminated feed in the infection chain. Efforts have been made or are being considered in the meat and poultry industry to reduce the salmonellae and other microbiological loads.

At the same 1975 meeting, Buyens discussed the role and make-up of the Secretary of Agricultures "Advisory Committee on Salmonella", and the general problems existing in Salmonella control efforts.

There is definite evidence that progress can be made in control. Drs. Pomeroy and Kumar, of the University of Minnesota, have stated that salmonellosis in poultry has been recognized for many years. They further indicated that in the past 10 years, the public health significance of the disease has been well documented with
meat and poultry products being considered major sources of human infection.  

Over a 3 year period they conducted an extensive study in 18 fryer-roaster turkey flocks, representing 200,000 turkeys from the hatchery to the processing plants. The sources of salmonellae identified were:

1. Infected breeder flocks resulting in egg transmission and introduction of the agent into the hatchery and infecting newly hatched poultis.
2. Contaminated environment of the turkey buildings resulting in the infection of turkeys.
3. Contaminated feed resulting in the introduction of salmonellae into turkey flocks and environmental contamination.

They concluded that if infections were to be reduced and ultimately eliminated in poultry—three major areas need to be approached:

1. Elimination of salmonellae from feed ingredients and completed feeds.
2. Development of sanitation programs to eliminate the pathogens from contaminated poultry buildings.
3. Development of *Salmonella*-free breeding flocks.

Efforts have continued in Minnesota to reduce salmonellosis in turkeys. During 1975-76, the laboratories of the Minnesota Livestock Sanitary Board tested 197 flocks involving 596,319 birds for salmonellae. Of the flocks tested, 50 (25.25%) flocks were detected to be positive. The testing showed a decline (14.27%) from the 1975 figure of 39.52%.

A dramatic reduction in the prevalence in breeding flocks is shown by the following data from a Minnesota hatchery that was voluntarily using a *Salmonella* control plan. In the preceding year of the initiation of the program, *S. typhimurium*, *S. newport*, *S. st. paul*, *S. bredeny* and *S. heidelberg* had been isolated from nine breeder flocks in the operation. A monitoring program of the breeder flocks and environment of the turkey buildings was initiated along with a cleaning and disinfecting program. By 1975-76, *S. bredeny* and *S. reading* were isolated from three breeder flocks with elimination of *S. typhimurium*, *S. st. paul*, *S. heidelberg* and *S. newport* from the system.

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*Personal Communication, Dr. B. S. Pomeroy and Dr. M. C. Kumar, University of Minnesota, 1976.*
To determine if *Salmonella* free poult could be placed in a salmonellae free environment and sent to market salmonella free, a program was established with a commercial operation on six farms, 14 buildings, involving 139,000 birds raised to 17 to 19 weeks.

As a result of these studies, Pomeroy and Kumar concluded that:

a) it is possible to raise salmonellae-free turkeys if precautions are taken to prevent introduction of the agent from the feed, farm environment and hatchery.

b) the number of infected flocks can be reduced to a low level by taking all precautions.

Industry

Industry has recognized the need for increased emphasis to reduce salmonellae contamination of foods since 1967. This has had a tremendous impact on the food industry. Tompkin, a food microbiologist, indicates that while there has been improvement made in the incidence of food contamination, it is debatable whether this has led to the reduction in the incidence of human foodborne salmonellosis. Industrial microbiologists recognize and support the need for controlling the pathogen in food. There is a reason when salmonellae is found in a food plant environment and the bacteria usually can be brought under control.

Tompkin questioned the attitude that “Salmonellosis—is the ubiquitous bug” and indicates that in food plant investigations that this is a false impression. He states that once sites of salmonella contamination are detected and corrections are made, it is possible to eliminate the organism or bring it under control to the point where it is not detectable. He calls for a positive attitude towards salmonella control and that the programs be developed which will be sustained at corporate, university and governmental levels which will lead continually and progressively toward improved salmonellae control and hopefully reduction in the incidence of foodborne salmonellosis.

International Efforts

Salmonellosis continues to exist as an international problem. In the United Kingdom, recognition that animals including poultry are the main reservoirs of infection, led to the 1975 Zoonoses Order under the Diseases of Animals Act which aims to improve the control of diseases transmissible from animals to man. It provides legal authorization to investigate and control *Salmonella* and *Brucella* infections in animals and infections in birds which represent a threat to human health. There is consideration for legislation called the “Protein Processing Order” or the basic purpose will ensure that, a) any material of animal, bird or fish origin which may be in-
corporated in feeding meal intended for livestock and poultry, is processed at premises licensed by the Agriculture Departments, b) that the method of processing is efficient to destroy those organisms which may give rise to diseases of livestock and poultry particularly salmonellosis; and c) that no recontamination of the processed product takes place in licensed premises.

An extensive project is being conducted on Walcheren Island, in the Netherlands, in an attempt to control salmonellosis. It is suggested that the following cycle of infection takes place: slaughter animal-meat-human-consumer-effluent and surface water-insects, birds and rodents-slaughter animal. In 1973, I had the opportunity to visit the Walcheren Island Project. It is essentially a closed community with about 300 farms. In this program the use of pelleted feed had been implemented—with a usage of 90-95% occurring—and an estimated 50% of pelleted feeds usage in the total country.

In Sweden, there is concern for prevention of salmonellosis on farms. In an effort to control the disease, consideration is being made to discontinue liquid manure disposal waste systems.*

At the recent 2nd International Congress on Animal Hygiene, held in Yugoslavia (Oct, 1976), 270 veterinarians from 20 countries participated. Concern was expressed on the control of salmonellosis in food producing animals. Veterinarians and livestock producers can acquire extensive knowledge from the experience of our European colleagues.

National Efforts

At the 1975 USAHA Annual Meeting, the Salmonellosis Committee indicated by resolution the need for USDA funding to support development of safe, effective and economical procedures for chemosterilization or other methods to inactivate salmonella in feeds, in feed ingredients, to prevent recontamination of feeds, and to decontaminate feeds that may be recontaminated. Great concern was expressed by resolution to ask USDA to request funding, to reestablish a Salmonella Reference Center and to provide the needed technical support.

The USAHA Salmonellosis Committee re-emphasized the need to attack salmonellosis as a total environmental problem instead of attacking only segments, and re-emphasized that effective control of the disease in domestic animals and man can only be achieved by a thorough understanding of its epidemiology.21

At the October, 1976 meeting of the AVMA Council on Public

*Personal Communication, Dr. I. Ekesbo, Skara, Sweden, 1976.
Health and Regulatory Veterinary Medicine, support was given to the National Symposium on Salmonellosis planned for January in Washington, D.C., 1978 so that this major public health and economic livestock disease will again be brought to the attention of federal agencies. The Council is also concerned that a workable program to prevent spread of numerous salmonella serotypes can be developed and that a cooperative federal-state program will again be re-instituted.

Future

It is essential that a more positive National attitude and that long term efforts toward salmonellae control be re-established.

Priority needs that have been previously identified by the USDA established Advisory Committee on Salmonella should be re-emphasized. Objectives of the committee were to reduce the incidence of salmonella in humans, animals, and poultry. Duties of the Advisory Committee are as follows:

—Studying measures to reduce the incidence of Salmonella organisms in live poultry and animals, and to limit the spread of contamination during slaughtering, eviscerating, and further processing operations;
—Recommending and soliciting the cooperation of affected industries in implementing measures which are developed;
—Recommending regulatory requirements needed to apply critical control group procedures; and
—Considering means of disseminating information on preventive practices to all segments of industry and to consumers.

The discussions and efforts of the USAHA Salmonellosis Committee at this meeting and the forthcoming National Symposium on Salmonellosis planned for 1978 must give re-direction and greater effort to this costly public health disease problem.
Table 1  The 10 most frequently reported serotypes of Salmonella isolated from human and nonhuman sources in the United States, 1968-1974.

<table>
<thead>
<tr>
<th>Source, serotype</th>
<th>No. of isolations</th>
<th>Percentage of total</th>
<th>1963-1967 ranking (% of total)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Human</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>typhimurium*</td>
<td>44,395</td>
<td>26.5</td>
<td>1 (29.8)</td>
</tr>
<tr>
<td>enteriditis</td>
<td>13,026</td>
<td>7.8</td>
<td>6 (5.2)</td>
</tr>
<tr>
<td>newport</td>
<td>12,139</td>
<td>7.2</td>
<td>3 (5.9)</td>
</tr>
<tr>
<td>heidelberg</td>
<td>9,844</td>
<td>5.9</td>
<td>2 (8.1)</td>
</tr>
<tr>
<td>infants</td>
<td>8,961</td>
<td>5.4</td>
<td>4 (5.9)</td>
</tr>
<tr>
<td>saint-paul</td>
<td>7,307</td>
<td>4.4</td>
<td>7 (3.6)</td>
</tr>
<tr>
<td>thompson</td>
<td>5,112</td>
<td>3.0</td>
<td>10 (2.4)</td>
</tr>
<tr>
<td>typhi</td>
<td>4,065</td>
<td>2.4</td>
<td>8 (3.4)</td>
</tr>
<tr>
<td>derby</td>
<td>3,497</td>
<td>2.1</td>
<td>5 (5.3)</td>
</tr>
<tr>
<td>javiana</td>
<td>3,431</td>
<td>2.0</td>
<td>NL†</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>111,777</td>
<td>66.7</td>
<td></td>
</tr>
<tr>
<td><strong>All other</strong></td>
<td>55,680</td>
<td>33.3</td>
<td></td>
</tr>
<tr>
<td><strong>Grand total</strong></td>
<td>167,457</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td><strong>Nonhuman</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>typhimurium*</td>
<td>2,330</td>
<td>20.7</td>
<td>1 (17.3)</td>
</tr>
<tr>
<td>heidelberg</td>
<td>1,207</td>
<td>10.7</td>
<td>2 (9.2)</td>
</tr>
<tr>
<td>anatum</td>
<td>859</td>
<td>7.6</td>
<td>4 (5.1)</td>
</tr>
<tr>
<td>saint-paul</td>
<td>809</td>
<td>7.2</td>
<td>5 (4.1)</td>
</tr>
<tr>
<td>infants</td>
<td>807</td>
<td>7.2</td>
<td>3 (5.5)</td>
</tr>
<tr>
<td>montevideo</td>
<td>748</td>
<td>6.7</td>
<td>6 (4.0)</td>
</tr>
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<td>seftenberg</td>
<td>625</td>
<td>5.6</td>
<td>NL</td>
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<tr>
<td>thompson</td>
<td>561</td>
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<td>NL</td>
</tr>
<tr>
<td>derby</td>
<td>521</td>
<td>4.6</td>
<td>7 (3.4)</td>
</tr>
<tr>
<td>eimsbuettel</td>
<td>480</td>
<td>4.6</td>
<td>NL</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>8,947</td>
<td>79.6</td>
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<tr>
<td><strong>All other</strong></td>
<td>2,294</td>
<td>20.4</td>
<td></td>
</tr>
<tr>
<td><strong>Grand total</strong></td>
<td>11,241</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

* Includes var. copenhagen.

† NL = not listed.
### Table 2

**Results: Salmonella Isolations, Pomprop & Kumar (1973-76) Minnesota.**

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Poultry Bldgs. Examined</th>
<th>No. of Bldgs. with <em>Salmonella</em> Isolations</th>
<th>% Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973-74</td>
<td>38</td>
<td>14</td>
<td>36.84</td>
</tr>
<tr>
<td>1975-76</td>
<td>71</td>
<td>5</td>
<td>7.04</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of cloacal squeezing samples examined</th>
<th>No. with isolations of <em>Salmonella</em></th>
<th>No. of hatcher fluff sample examined</th>
<th>No. with isolation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973-74</td>
<td>1,392</td>
<td>54 (3.9%)</td>
<td>500</td>
<td>34 (6.8%)</td>
</tr>
<tr>
<td>1975-76</td>
<td>528</td>
<td>2 (0.38%)</td>
<td>453</td>
<td>1 (0.22%)</td>
</tr>
</tbody>
</table>

### Table 3

**Number of breeder flocks found positive for *Salmonella* under the Minnesota testing programs.**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(30.7%)</td>
<td>(26.0%)</td>
<td>(20.0%)</td>
<td>(23.3%)</td>
<td>(20.0%)</td>
</tr>
</tbody>
</table>
REFERENCES


2. Bixler, W. B.: Past Salmonella Control Activities for Rendered Products, "Where We Are Now". Speech presented at the Salmonella National Advisory Committee Meeting, on Feb. 25, 1976, by committee member, Dr. William B. Bixler, Acting Director, Division of Veterinary Medical Review, BVM, FDA.


REPORT OF THE COMMITTEE ON SALMONELLA

Chairman: Erskine V. Morse, Lafayette, IN
Co-Chairman: H. G. Geyer, Washington, DC

The Committee was pleased to have with us a number of distinguished guests representing most facets of the livestock industry as well as state and federal regulatory agencies. The guests contributed much to the discussions and provided valuable counsel to the Committee.

Dr. William B. Bixler, FDA Bureau of Veterinary Medicine discussed the position and status of F.D.A. activities related to salmonellosis in animals and the impact of these programs as they pertain to public health. Dr. Bixler's position paper is included as part of the Committee's Report for publication.

Dr. Billie O. Blackburn, U.S.D.A.-A.P.H.I.S. presented a detailed report of the serotyping activities at National Animal Disease Center, Ames, Iowa. This important service to animal disease diagnostic laboratories as well as researchers in animal diseases and epidemiology is a keystone in assessing the incidence, distribution and losses due to Salmonella. The report is included as part of the Committee's Report.

Dr. Cornwell W. Johnson, National Renderers Association, updated the committee on recent developments on the disinfection of rendered products to destroy salmonella.

The Committee chairman was instructed by President Goldstein and the 1975 Committee chairman, Dr. Harry G. Geyer, to develop plans for a National Salmonellosis Symposium to be held at the U.S.D.A. main auditorium in Washington, D. C. in January 1978. Co-sponsorship of other organizations and agencies was to be sought by President Goldstein and the 1976 Chairman. As a result of this charge to the Committee, the following organizations have formally joined U.S.A.H.A. in sponsoring the Symposium:

American Veterinary Medical Association (represented by Dr. Donald Spangler, Treasurer, A.V.M.A.)

U. S. Department of Agriculture:
C.E.S.—represented by Dr. Harry Geyer
A.P.H.I.S.—represented by Drs. Harry Mussman and William Dubbert

Center for Disease Control (P.H.S.), Atlanta, Ga.
Represented by Dr. Morris E. Potter
F.D.A.—Bureau of Veterinary Medicine (represented by Dr. William B. Bixler)


Support and co-sponsorship is being considered by several other groups concerned with salmonellosis in animals and man.

The Committee discussed possible dates for the Symposium. It was concluded that the meeting be held on either Tuesday and Wednesday or Thursday and Friday sometime during the first two weeks in January 1978. Dr. Geyer, Co-chairman of the committee has been requested to make arrangements, hopefully for the second week in the month, to reserve the U.S.D.A. Auditorium.

The audience we hope to reach consists of State Cooperative Extension Service specialists in Home Economics, Veterinary Medicine, Animal/Poultry Science, Livestock/Poultry producers, processors as well as retailers. We are most desirous of reaching the consumers and those involved in mass distribution and serving of food. The subject matter will not be at the dialogue level of scientists conversing with scientists. The aim of the Symposium is to provide a knowledge update to the responsible citizenry at the grass-roots level. Speakers will be sought who are authorities in the field of salmonellosis. Presentations will stress the applied aspects of epidemiology, detection, prevention and control of salmonellae infections in both animals and man.

The Committee discussed several resolutions which we respectfully request our parent organization, the U.S.A.H.A., to make formally to the appropriate federal agencies and legislative or regulatory bodies concerned with these activities.

These resolutions are as follows:

1. That the U.S.D.A. and F.D.A. continue their excellent public information salmonellosis releases via radio and television as well as other news media. These do much to educate the U. S. public as to the significance of salmonellosis and its prevention at the consumer level.

2. That adequate and critically needed support be provided to continue the serotyping and diagnostic support for salmonellae activities of the National Animal Disease Center—A.P.H.I.S., Ames, Iowa and the Center for Disease Control (Dept HEW, PHS), Atlanta, Ga. These are presently the only laboratories which provide these essential services to all of the fifty states and U. S. possessions.
3. That support be provided for the envisioned national salmonellosis reporting service in animals and poultry which is being developed by the American Association of Veterinary Laboratory Diagnosticians in conjunction with other concerned national groups.

4. That the U.S.A.H.A. recommend and seek legislative support and funding for salmonellosis research in these critical areas which relate directly to human and animal health and well-being, i.e.: a) Identifying sources of salmonellae in the environment, i.e. water, effluents, aquatic fauna—especially edible fish, and wildlife.

b) Assessing the role and public health aspects of salmonellosis in companion animals, i.e. housepets, including caged birds, reptiles and aquarium fishes. Salmonellosis in horses is a serious problem which has resulted in human infections.

c) Ascertaining physiological and toxicological parameters which effect the course and outcome of salmonellosis. Such knowledge would do much in providing more effectual preventive and control measures.

d) Assessing ways and means of breaking the transmission cycle of salmonellae in livestock and poultry.

e) Developing more efficient, yet accurate, means of detecting and identifying Salmonella clinical cases and carrier animals.

f) Devising adequate and safe methods for disinfection of feeds and feed supplements to eliminate salmonellae in these products fed to livestock, poultry and pet animals. It should be remembered that dog foods are sometimes consumed by unfortunates in the lower socio-economic groups.

Mr. Chairman: The report of the Committee on Salmonella with addenda and resolution is respectfully submitted to the parent body, the U. S. Animal Health Association.

We request concurrence and action on the resolutions submitted by your Committee on Salmonella.
INTRODUCTORY

On May 16, 1975, the Commissioner of the Food and Drug Administration (FDA) forwarded to Dr. Mulhern, Administrator, Animal and Plant Health Inspection Service (APHIS), a letter outlining the past events in FDA concerning Salmonella committees and programs in which our agencies were involved, and summarized present endeavors to control the Salmonella level in food:

For six years (1966-1972), the FDA and the U.S. Department of Agriculture (USDA) functioned under a Memorandum of Understanding in a Cooperative State-Federal Salmonella Program for the animal and marine protein industries. However, on June 7, 1972, the Bureau of Veterinary Medicine (BVM) received a memorandum from Dr. E. E. Saulman, Acting Deputy Administrator, stating that due to expected limitations in funds and personnel ceilings in FY '73, the Veterinary Services of APHIS was discontinuing the program as of June 30, 1972.

On May 7, 1973, the Report of the FDA Salmonella Task Force was submitted to the Commissioner's office. The report was accepted and certain assignments were issued from the Commissioner's office to the FDA bureaus, which conducted program activities in this area. BVM was charged with: (1) pursuing a Voluntary Cooperative Federal-State-Industry Salmonella Control Program for animal and marine by-products; and, (2) conducting a field survey of the blending plants of rendered animal and marine by-products.

A BVM Salmonella Working Committee was formed with representatives from appropriate State and industry national organizations and representatives from Federal Agencies (USDA, FDA, and the Department of Commerce), to meet and develop a Voluntary Cooperative Salmonella Program.

Adoption of an equitable Cooperative Salmonella Control Program would require resources beyond those available at the present time. Thus, we find FDA in a position similar to the one APHIS removed itself from several years ago. (we refer to Dr. Mulhern's letter of justification, reference number B-164031(2), dated February 27, 1973, to Mr. Richard J. Woods, Assistant Director, Resources

*Acting Director, Division of Animal Feeds, BVM, FDA
**Presented before the USAHA Salmonella Committee.
The Commissioner of FDA then decided that an Operations Research Study was necessary to reassess implementation of the Cooperative Salmonella Control Program in order to determine whether the resources necessary are commensurate with the benefits to be gained. It was the Commissioner’s decision that FDA would base its further participation in the Cooperative Salmonella Program for rendered by-products on the conclusions reached in this study.

On February 14, 1976, the Commissioner accepted the recommendations of the Task Force found in the Position Paper resulting from the Salmonella Operations Research Study, that FDA not initiate any new Federal regulatory programs directed at the animal and marine by-products industry, with the exception of those individual cases exhibiting a clear and present danger to public health.

Also, he has decided to discontinue the detention of imported rendered products in order to be consistent with the recommendation found in the Position Paper concerning domestic products.

Moreover, FDA is proceeding to vacate all injunctions against domestic rendering plants and their products, since the current posture of the Agency does not support the continuation of these injunctions.

SUMMARY OF THE POSITION PAPER

A. Purpose

This report reassesses the advisability of implementing an equitable cooperative Salmonella program to assure the production of Salmonella negative animal and marine rendered by-products. The “Proposed Program for the Control of Salmonella in Rendered Animal and Marine Products Intended for Use in Animal Feeds,” involved the participation of the FDA, the states, and the industry. It was developed for the renderers of animal and marine products only, not the blenders of the rendered products. The report, therefore, deals only with regulation of the rendering industry. The price of a regulatory program is considered in terms of cost to the FDA, to the industry, and to the consumer. The benefits to be derived from the program were examined and the probability of success, in terms of reduction of human salmonellosis were considered.

The Task Force designated to conduct this study was asked to answer two specific questions in the course of its evaluation:

1. What is the contribution of Salmonella contaminated rendered
animal and marine by-products to animal and human salmonellosis?

2. Does the contribution of *Salmonella* in animal feed ingredients to animal and human salmonellosis warrant the resources required to eliminate such contamination?

B. Conclusions

The conclusions of the Task Force, aided greatly by the literature search and analysis conducted by Dr. E. M. Foster and Dr. R. H. Deibel, College of Agriculture and Life Sciences, University of Wisconsin, and included as part of the Report, are as follows:

1. The presence of *Salmonella* in rendered animal and marine by-products used in animal feed does contribute to salmonellosis in animals and man.

   a. Food sources of the disease for man.
      The principal means of infection by *Salmonella* in man is via the oral route. Contaminated food, most frequently fresh poultry and meat and eggs, transmit the organism.

   b. Other sources of the disease for man.
      Other sources of the disease for man are human carriers and contact with domestic or wild animal carriers.

   c. Source of the disease for animals.
      Animals may contact salmonellosis from each other, from environmental sources such as soil, water, and air, and from rodents.

2. There are many potential sources of *Salmonella* infection in animals. No single source can be clearly implicated as the major contributor to the spread of the disease in animals.

   a. A survey of members of the Salmonella Committee of the American Association of Avian Pathologists and other *Salmonella experts* (27) failed to reach a consensus as to which means of transmission was clearly the major source of *Salmonella* infections.

      Although feed was considered an important source of poultry infection by the majority of the respondents, over half considered environmental sources, animal-to-animal, and generation-to-generation transmission to also be important sources of infection.

      In the case of swine and cattle, animal-to-animal transmission and environmental contamination were considered to be important by more respondents than were feed sources.
b. In approximately ten years of research and epidemiology, this basic issue has never been resolved.

_Salmonella_ has been demonstrated to be perpetuated in poultry flocks by transovarian infection of eggs, by contaminated pens and by wild and domestic animals. Intensive rearing practices favor the rapid spread of disease within flocks. In swine and cattle, transmission by animal-to-animal contact, particularly in stress situations which occur in transit and holding pens, has frequently been cited as a leading cause of the spread of infection.

3. Any program to eliminate _Salmonella_ from rendered animal and marine by-products would result in higher prices for the feed industry and ultimately for the consumer. The promulgation of any program would involve an unacceptably high expenditure of resources.

a. _Cost to FDA_. Previous studies conducted by FDA indicate a direct annual cost to FDA as follows:

- Inspection of every rendering plant once every five years
  - $575,000
- Inspection of every rendering plant annually
  - $1,500,000
- Inspection of every rendering plant and each feed mill annually
  - $3,700,000

(This does not include any follow-up inspection and sample analysis)

b. _Cost to Consumer_. The consumer will bear the financial burden of regulatory programs through taxes and any additional costs incurred by industry will be reflected through increased product prices.

c. _Cost to Industry_. The cost to industry will be both direct and indirect. The direct costs will involve increased capitalization for plant modification and equipment needs. Industry sources estimate an average of $150,000 capitalization/plant would be required to bring plants to reasonable status of performance (600 plants @ $150,000 = 90 million dollars). Indirect costs would include taxes, interest, utilities, etc. Under these circumstances marginal plant operations might be forced to discontinue services because of the additional capital requirements.

4. Education of the public in the proper handling and preparation of fresh meat and poultry should be continued.
More than half of the salmonellosis outbreaks reported to the Center for Disease Control between 1966 and 1971 were traced to improper food handling procedures in the home and in commercial food establishments. The public must be informed that bacteria, including *Salmonella*, are present on the surface of meat and poultry. However, precautions taken to avoid contamination of food which is consumed raw and proper storage and cooking of raw meat and poultry can effectively exclude these products as a major cause of human salmonellosis.

C. Task Force Response to Charge Questions

1. *Salmonella* contaminated rendered animal and marine by-products do contribute, in part, to animal and human salmonellosis, however, the contribution has not been measured because other *Salmonella* sources are acting simultaneously in the population at risk.

2. Based upon the probable cost-benefit ratio, the contribution of rendered animal and marine by-products to animal and human salmonellosis does not warrant the expenditure of resources necessary to eliminate *Salmonella* from animal feed ingredients.

D. Recommendations

Considering the above conclusions and costs, the Task Force recommended that FDA *not* initiate any new Federal regulatory programs directed solely at the animal and marine by-products industry, with the exception of those individual cases exhibiting a clear and present danger to public health.

E. Addendum Report

Not being a part of this Task Force's charge, the following conclusions are recognized as ancillary but promising in nature. The potential of these programs, although not within FDA's responsibility, appears favorable.

1. A determination should be made as to how to alter those practices in animal husbandry and meat and poultry processing which lead to an increase in *Salmonella* organisms in animals presented for slaughter.

   Consideration should be given to see if it is economically feasible to permit livestock consigned for slaughter to return to a normal physiological state before slaughter.

2. A research program should be considered to gain an understanding of those factors which lead to the development of clinical salmonellosis in animals and man.
a. While it is considered that "stress" is a precipitating factor which leads to the development of clinical symptoms of salmonellosis in previously asymptomatic carriers, the physiological mechanisms through which "stress" acts, are largely unknown.

b. *Salmonella* transmission at the processing plant should be reduced. The most logical place in the production chain which can be singled out for remedial measures is the meat processing plant and related animal handling facilities.

**EDUCATIONAL PROGRAMS**

As has been agreed upon, FDA and USDA each will continue educational programs to inform consumers about precautions to be taken when preparing and cooking foods, in order to minimize risk of *Salmonella* infection.

**BLENDER SURVEY**

The blender survey conducted by FDA has been completed and is presently under review. The 1973 Salmonella Task Force estimated there were 40 firms in the United States that were blending animal and marine products which constituted an estimated 60 percent of the total rendered products used in animal feeds. This Task Force suggested by covering the blenders under a surveillance program, FDA would be using their limited resources and thus be controlling more than half of the rendered protein by-products.

Preliminary reports of this survey indicate that based on estimated values (dollar sales) approximately 24 percent of the protein by-products from the rendering industry are further processed by the 27 blending establishments reported. Therefore, it is dubious that a compliance program directed to the blenders only will provide coverage of any major portion of the rendering industry's output as was contemplated in the Salmonella Task Force Report of 1973.
SUMMARY

Serotyping of salmonella and Arizona cultures from animal disease cases and epidemiologically related sources is reported for July 1, 1974, through June 30, 1975. A total of 3,593 cultures was serotyped. The most frequently identified salmonella serotypes were Salmonella typhimurium, S. typhimurium var. Copenhagen, S. cholerasuis var. Kunzendorf, S. heidelberg, and S. anatum. The most frequently identified Arizona serotype was 7a, 7b:1, 7, 8. Turkeys were the most frequent source of cultures and were followed, in order, by cattle, swine, and chickens.

INTRODUCTION

The Animal and Plant Health Inspection Service, USDA, maintains the salmonella reference center at Veterinary Services Laboratories, Ames, Iowa. A primary function of the reference center is serotyping of salmonella and Arizona cultures from other laboratories in support of animal disease diagnoses. Other animal health laboratories have serotyping capability and cooperate in reporting their serotyping activities. In addition to the reference center activities, this report includes information from the Animal Health Laboratories of the Wisconsin Department of Agriculture.

Caution must be exercised when interpreting these data. A major consideration must be the fact that the report is based on numbers of cultures serotyped rather than on cases of disease. The relationship between cultures serotyped and cases cannot usually be determined. Local interest and assessment of the economic importance of salmonellosis coupled with availability of laboratory service also seem to be quite variable.

No attempt is made to analyze the data extensively. Rather, the raw data is presented (Tables 1-4) so that it will be available for epidemiologists. More commonly needed summaries are provided in Figure 1 and Tables 5-10.

DISCUSSION

The 3,593 cultures reported for FY 1975 are a drastic reduction from the report for the previous year1. This is mostly explainable
as due to a concerted effort to reduce unnecessary serotyping and refine the data. It is not appropriate to interpret this as being due to a reduction in the salmonella problem.

The appearance of *S. enteritidis* among the 10 most common serotypes (Table 10) is largely due to problems in white pekin ducks in New York. Serotyping records did not show the number of flocks involved nor the morbidity and mortality data.

Another serotype which should get some attention is *S. agona*. In the short time from 1968 to 1975, identifications of this serotype have increased steadily from 0 to 89 per year. It now appears among the 10 most common from turkeys, chickens, and swine and ranks 12th overall. These statistics compare well with those from humans. In 1974 *S. agona* ranked 6th most common and the first identification in the United States was recorded in 1967. This serotype does not appear to have any host or geographical adaptations.
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| 9A,9R:129-31 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26:26-25 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18:13:14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1,33:124:125 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 512:4-25 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33:20-26 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 28:32-22 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1,4:129-31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16123-34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19123-23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16121-22 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4,33:133-28 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1533:23-21 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13:22-26-21 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21:26-25 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10A,10C:131 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30:127-26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9A,9C:133-31 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2111:2+5 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1,4:127-21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9A,9C:129-31 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**TOTALS** | 10 | 68 | 1 | 1 | 6 | 2 | 12 | 6 | 1 | 50 | 18 | 2 | 3 | 1 | 4 | 3 | 2 | 5 | 8 | 2 | 21
SALMONELLA AND ARIZONA SEROTYPES

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(A) VAR 14 (B) VAR KUNZENDORF (C) VAR JERUSALEM (D) VAR COPENHAGEN
## TABLE 4. DISTRIBUTION OF ARIZONA SEROTYPES BY SOURCE - FW75

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<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1:41:27-21</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<td>0</td>
<td>1</td>
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<tr>
<td>9A:9C129-31</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**TOTALS** 151 3 5 3 1 11 40 9 2 1 226
### Table 5. Turkey--Most Frequently Identified Serotypes in FY 75

<table>
<thead>
<tr>
<th>Serotype</th>
<th>Times Identified</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>7a,7b:1,7,8</td>
<td>151</td>
<td>18.41</td>
</tr>
<tr>
<td>Saint Paul</td>
<td>112</td>
<td>13.66</td>
</tr>
<tr>
<td>Heidelberg</td>
<td>100</td>
<td>12.20</td>
</tr>
<tr>
<td>San Diego</td>
<td>98</td>
<td>11.95</td>
</tr>
<tr>
<td>Anatum</td>
<td>71</td>
<td>8.66</td>
</tr>
<tr>
<td>Typhimurium</td>
<td>44</td>
<td>5.37</td>
</tr>
<tr>
<td>Reading</td>
<td>39</td>
<td>4.76</td>
</tr>
<tr>
<td>Bredeney</td>
<td>30</td>
<td>3.66</td>
</tr>
<tr>
<td>Agona</td>
<td>26</td>
<td>3.17</td>
</tr>
<tr>
<td>Senftenberg</td>
<td>21</td>
<td>2.56</td>
</tr>
<tr>
<td><strong>Total of 10 serotypes</strong></td>
<td><strong>692</strong></td>
<td><strong>84.39</strong></td>
</tr>
</tbody>
</table>

### Table 6. Chicken--Most Frequently Identified Serotypes in FY 75

<table>
<thead>
<tr>
<th>Serotype</th>
<th>Times Identified</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infantis</td>
<td>71</td>
<td>12.01</td>
</tr>
<tr>
<td>Heidelberg</td>
<td>67</td>
<td>11.34</td>
</tr>
<tr>
<td>Worthington</td>
<td>47</td>
<td>7.95</td>
</tr>
<tr>
<td>Typhimurium var. Copenhagen</td>
<td>45</td>
<td>7.61</td>
</tr>
<tr>
<td>Thompson</td>
<td>42</td>
<td>7.11</td>
</tr>
<tr>
<td>Pullorum</td>
<td>41</td>
<td>6.94</td>
</tr>
<tr>
<td>Typhimurium</td>
<td>37</td>
<td>6.26</td>
</tr>
<tr>
<td>Agona</td>
<td>23</td>
<td>3.89</td>
</tr>
<tr>
<td>Enteritidis</td>
<td>21</td>
<td>3.55</td>
</tr>
<tr>
<td>Anatum</td>
<td>20</td>
<td>3.38</td>
</tr>
<tr>
<td><strong>Total of 10 serotypes</strong></td>
<td><strong>414</strong></td>
<td><strong>70.05</strong></td>
</tr>
</tbody>
</table>
### Table 7. Cattle--Most Frequently Identified Serotypes in FY 75

<table>
<thead>
<tr>
<th>Serotype</th>
<th>Times Identified</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typhimurium</td>
<td>354</td>
<td>49.17</td>
</tr>
<tr>
<td>Typhimurium var. Copenhagen</td>
<td>157</td>
<td>21.81</td>
</tr>
<tr>
<td>Dublin</td>
<td>83</td>
<td>11.53</td>
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<tr>
<td>Newport</td>
<td>25</td>
<td>3.47</td>
</tr>
<tr>
<td>Anatum</td>
<td>24</td>
<td>3.33</td>
</tr>
<tr>
<td>Montevideo</td>
<td>7</td>
<td>0.97</td>
</tr>
<tr>
<td>Enteritidis</td>
<td>6</td>
<td>0.83</td>
</tr>
<tr>
<td>Meleagridis</td>
<td>5</td>
<td>0.69</td>
</tr>
<tr>
<td>Thompson</td>
<td>4</td>
<td>0.56</td>
</tr>
<tr>
<td>Oranienburg</td>
<td>4</td>
<td>0.56</td>
</tr>
<tr>
<td><strong>Total of 10 serotypes</strong></td>
<td><strong>669</strong></td>
<td><strong>92.92</strong></td>
</tr>
</tbody>
</table>

### Table 8. Swine--Most Frequently Identified Serotypes in FY 75

<table>
<thead>
<tr>
<th>Serotype</th>
<th>Times Identified</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choleraesuis var. Kunzendorf</td>
<td>342</td>
<td>54.46</td>
</tr>
<tr>
<td>Typhimurium</td>
<td>84</td>
<td>13.38</td>
</tr>
<tr>
<td>Derby</td>
<td>37</td>
<td>5.89</td>
</tr>
<tr>
<td>Typhimurium var. Copenhagen</td>
<td>34</td>
<td>5.41</td>
</tr>
<tr>
<td>Agona</td>
<td>20</td>
<td>3.18</td>
</tr>
<tr>
<td>Anatum</td>
<td>17</td>
<td>2.71</td>
</tr>
<tr>
<td>Newport</td>
<td>12</td>
<td>1.91</td>
</tr>
<tr>
<td>London</td>
<td>11</td>
<td>1.75</td>
</tr>
<tr>
<td>Worthington</td>
<td>10</td>
<td>1.59</td>
</tr>
<tr>
<td>Enteritidis</td>
<td>7</td>
<td>1.11</td>
</tr>
<tr>
<td><strong>Total of 10 serotypes</strong></td>
<td><strong>574</strong></td>
<td><strong>91.40</strong></td>
</tr>
</tbody>
</table>
Table 9. Horse--Most Frequently Identified Serotypes in FY 75

<table>
<thead>
<tr>
<th>Serotype</th>
<th>Times Identified</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typhimurium</td>
<td>79</td>
<td>45.93</td>
</tr>
<tr>
<td>Typhimurium var. Copenhagen</td>
<td>26</td>
<td>15.12</td>
</tr>
<tr>
<td>Anatum</td>
<td>18</td>
<td>10.47</td>
</tr>
<tr>
<td>Newport</td>
<td>12</td>
<td>6.98</td>
</tr>
<tr>
<td>Meleagridis</td>
<td>7</td>
<td>4.07</td>
</tr>
<tr>
<td><strong>Total of 5 serotypes</strong></td>
<td><strong>142</strong></td>
<td><strong>82.56</strong></td>
</tr>
</tbody>
</table>
Table 10. Salmonella Serotypes Identified Most Frequently during FY 1975 with Comparison Data for 5 Years (All Sources)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Typhimurium</td>
<td>721* (1)**</td>
<td>1837 (1)</td>
<td>1158 (1)</td>
<td>676 (2)</td>
<td>805 (1)</td>
<td>762 (2)</td>
</tr>
<tr>
<td>Typhimurium var. Copenhagen</td>
<td>349 (2)</td>
<td>570 (2)</td>
<td>413 (2)</td>
<td>327 (5)</td>
<td>239 (7)</td>
<td>230 (12)</td>
</tr>
<tr>
<td>Choleraesuis var. Kunzendorf</td>
<td>346 (3)</td>
<td>404 (3)</td>
<td>290 (3)</td>
<td>133 (12)</td>
<td>245 (5)</td>
<td>573 (4)</td>
</tr>
<tr>
<td>Heidelberg</td>
<td>182 (4)</td>
<td>337 (4)</td>
<td>277 (5)</td>
<td>417 (3)</td>
<td>536 (2)</td>
<td>860 (1)</td>
</tr>
<tr>
<td>Anatum</td>
<td>163 (5)</td>
<td>323 (5)</td>
<td>198 (8)</td>
<td>187 (8)</td>
<td>302 (4)</td>
<td>611 (3)</td>
</tr>
<tr>
<td>Saint Paul</td>
<td>132 (6)</td>
<td>275 (6)</td>
<td>288 (4)</td>
<td>392 (4)</td>
<td>347 (3)</td>
<td>510 (5)</td>
</tr>
<tr>
<td>Newport</td>
<td>123 (7)</td>
<td>188 (8)</td>
<td>257 (6)</td>
<td>222 (7)</td>
<td>148 (14)</td>
<td>84 (23)</td>
</tr>
<tr>
<td>Enteritidis</td>
<td>105 (8)</td>
<td>72 (17)</td>
<td>63 (16)</td>
<td>34 (20)</td>
<td>75 (20)</td>
<td>101 (20)</td>
</tr>
<tr>
<td>San Diego</td>
<td>104 (9)</td>
<td>133 (10)</td>
<td>217 (7)</td>
<td>751 (1)</td>
<td>166 (13)</td>
<td>149 (16)</td>
</tr>
</tbody>
</table>
| * Number of times the serotype was identified. ** Rank beginning with the most common.
Figure 1. Geographical distributions of selected serotypes.
REFERENCES


PROGRESS IN THE SCRAPIE ERADICATION PROGRAM

A. L. Klingsporn*, DVM and J. L. Hourrigan, DVM

Scrapie is a naturally occurring disease of sheep and goats characterized by progressive degeneration of the central nervous system which caused the affected animal to rub and scratch, become debilitated and incoordinated. Most affected animals die at 30 to 50 months of age after showing clinical signs of disease for one to six months.

The causative agent of scrapie has not been identified or completely characterized, however, the agent is transmissible, filterable, particulate, and is a self-replicating agent considered by most research workers to be a virus with unusual characteristics. The virus can be experimentally introduced into the host's body by many routes; epidurally, intradermally, intranasally, intraocularly, intraperitoneally, intravenously, orally, and by rubbing on the scarificed skin. Once the virus enters the host's body, it replicates and spreads to many of the body tissues where it establishes rather constant titer levels. Figure 1. However, it is not until the virus reaches detectable levels in the brain rather late in the infection that lesions can be detected and the clinical signs of scrapie observed.

Scrapie has been recognized in Europe for over 200 years. It has been reported in many countries of Western and Eastern Europe, Colombia in South America, Kenya, and the Republic of South Africa in Africa, Australia, Canada, India, New Zealand, and the United States. Figure 2. The disease has not been officially reported in Russia, however, indications are that scrapie occurs there.

Scrapie spreads through the sale and movement of sheep, particularly of purebred sheep that are incubating the virus. Scrapie has spread to many countries of the world through the sale of purebred sheep from Europe, particularly Britain. The disease was first reported in Canada in 1938, and in the United States in Michigan in 1947. In both instances scrapie was first diagnosed in sheep imported from Great Britain or in descendants of British sheep. As of October 1976, the disease has been diagnosed in the United States in 214 flocks in 31 States. Figure 3. The 320 confirmed cases were: Cheviot, 16; Hampshire, 2; Montadale, 2; Suffolk, 298; and crossbreds, 2. Although scrapie has occurred in the majority of our States, the disease has not been reported for several years in many, for example, Missouri has had 9 outbreaks, but none reported for 9 years or since 1967.

*Chief Staff Veterinarian and Senior Staff Veterinarian, Sheep, Goat, Equine, and Ectoparasites Staff, VS, APHIS, USDA.
The Cooperative State-Federal Scrapie Eradication began in California in 1952 as an emergency measure. That program provided for histological confirmation of the disease in animals with clinical signs of scrapie, quarantine and slaughter of all sheep and goats in the infected flocks, and tracing and slaughter of all exposed animals moved from these flocks, and their immediate progeny. These procedures were effective and although California has suffered additional outbreaks, none have been extensions of the 1952 outbreaks.

Scrapie was next reported in five Ohio flocks in 1953. The eradication program that was followed in Ohio included slaughter of the infected flocks with tracing and inspection, but not slaughter, of exposed sheep sold from these flocks and their progeny. During inspections of these recipient flocks, certain of the exposed animals and their progeny were later found to have scrapie in Ohio and Tennessee. During the same year, scrapie was diagnosed in three Illinois flocks. The Illinois program provided for slaughter of infected flocks and exposed sheep moved from them.

It soon became obvious that the disease could not be effectively controlled or eradicated unless source flocks and movement from them were handled in the same manner as infected flocks. Source flocks were those determined to be disseminating scrapie, but in which scrapie had not been confirmed. The program was broadened in April 1957 to provide for slaughter of source flocks, exposed sheep sold from these flocks, and their immediate progeny.

The scrapie program was again modified in 1965 following an International Scrapie Seminar which was held to review scrapie and methods of control or eradication of this disease. These modifications expanded the program to include slaughter of bloodline as well as exposed animals. Bloodline animals are defined as the affected animals, all its descendants, sire and dam, and all full or half brothers or sisters. When the disease was limited to well-defined bloodlines and adequate quarantine measures could be maintained, slaughter could be limited to bloodline animals. Nonbloodline animals in infected and source flocks could be held under 24 months quarantine with an additional 18 months surveillance. This procedure was successful in small flocks where the affected animal had recently been introduced; however, in large purebred flocks where the affected animal(s) was born in the flock, additional cases occurred in all flocks so handled within a year in animals considered nonbloodline.

The latest modifications to the scrapie eradication program were implemented in September 1975 when Part 54, Title 9, Code of Federal Regulations was amended to: (1) Provide for the destruction of animals which have been directly exposed to scrapie; (2) eliminate salvage and use for human or animal consumption of bloodline and exposed animals; and (3) increase maximum Federal indemnity.
which may be paid for animals destroyed to $40 per head for grade animals and to $90 per head for purebred animals.

Thus, the present program provides for the observation of animals showing "scrapie-suspicious" signs, laboratory diagnosis of the disease in affected animals, quarantine of infected flocks, tracing the source of animals introduced into the infected flocks and exposed sales from the infected and source flocks, slaughter of the entire infected and source flocks, slaughter of selected bloodline animals and all exposed animals sold from the infected and source flocks and selected progeny, disposition of all animals slaughtered by burning or burial, payment of Federal indemnity for animals slaughtered, and conduct of a Scrapie Field Trial Study, Mission, Texas designed to study natural scrapie. Figure 4.

The present program places increased emphasis on the spread of scrapie by contact exposure and by the female vertically either prenatally or soon after birth to her offsprings, or laterally to other animals' offsprings pastured or housed with affected females. This program places less emphasis on the spread of scrapie via the apparently uninfected, but exposed sire to his offsprings or to other young animals because in many instances the male is never in physical contact with such animals. The reduced emphasis on the spread scrapie via the exposed ram does not, we believe, provide an unacceptable risk as the ram is considered much less likely to spread scrapie vertically than ewes. As a result of these changes, fewer sheep will require slaughter due to the ratio of ram progeny to ewe progeny. The prohibition of salvage of slaughtered exposed animals and the requirement that their carcasses must be disposed of by burning or burial has greatly reduced the possible human and animal health hazard from this disease.

The scrapie eradication efforts in the United States has been quite encouraging. The number of outbreaks in the Suffolk breed has declined and the program has held the spread of the disease in the Cheviot, Hampshire, and Montadale breeds to a negligible level. From a high of 22 outbreaks in 1956, outbreaks have gradually been reduced to 3 in 1971, 4 in 1972, 2 each in 1973, 1974, and 1975, and 5 in 1976. Figure 5. While it is our firm conviction that scrapie can be eradicated by following a rigorous quarantine and slaughter policy, the occurrence of five outbreaks during the past fiscal year clearly demonstrates that we must not let-down our guard and that all parts of the program must be actively and promptly carried out if the disease is to be eradicated. To do less invites the probability that scrapie will increase in the affected breeds, spread to the as yet unaffected breeds, and become so widespread and entrenched as to defy eradication.
STUDY OF NATURAL SCRAPIE, MISSION, TEXAS

The data obtained from study of field outbreaks, review of the research literature, and reports from other countries have long indicated that scrapie can be a significant disease, can spread by contact, and can cause substantial losses. The tendency in many countries to suppress reports of scrapie, limited research on the natural disease, and the eradication program carried out in the United States and Canada limited the accumulation of data regarding the true nature of scrapie, its spread, and losses caused by it.

To provide information in these areas, a field trial study was established at Moore Air Force Base, Mission, Texas in November 1964. The Mission field trial station is located on 450 acres of pastureland surrounding the run-ways of the former Moore Air Force Base. It was designed to hold and breed previously exposed and unexposed sheep and goats under close observation for extended periods to determine which animals would develop scrapie, and to study the natural spread of this disease. Five-hundred and forty-seven previously exposed sheep of the Cheviot, Hampshire, Montadale, and Suffolk breeds were purchased from flocks in California, Indiana, Illinois, Maryland, Missouri, New York, Texas, and Virginia, and taken to Mission, Texas for use in the field trial study. These sheep have been maintained in two areas: (1) a series of pasture and pens occupied by male animals only, and (2) a series of pastures and pens occupied by females and young progeny of both sexes. Lambing and kidding occurred in the female area, with lambs remaining with the dam until weaning, when the males are removed to the male area.

When evaluating the data from the Mission study, it soon became apparent that criteria had to be established to determine whether or not a given animal should be considered as being at risk for scrapie. After considerable study the following criteria was developed for animals considered at risk:

1. Scrapied—an animal confirmed scrapie by histological examination or by mouse inoculation.

2. Free—an animal dying at greater than 24 months of age which was negative clinically and negative on histological study, or an animal brought to Mission that is alive and healthy at 100 months or greater age, or died after living at least to 100 months of age, and was not clinically suspicious or histologically incclusive. Animals born at Mission had to meet similar criteria except the minimum age was 60 rather than 100 months. One hundred months was established as a criteria for animals brought to Mission, and 60 months for animals born at Mission because it was found that animals born in the Mission environment developed scrapie consistently at the younger age compared to those brought there.
Using these criteria for the 483 Suffolks taken to Mission, it was found that during the period from November 1964 to February 1976, some 315 met the criteria for being at risk, 92 or 29 percent of these animals developed scrapie at ages ranging from 23 to 142 months, while 223 remained free. Table 1. We believe that these levels of losses from a single disease is not compatible with economic production. Additional study of Table 1 reveals that 395 progeny were born at Mission from the previously exposed Suffolks brought there that meet the criteria for being considered at risk. One hundred and forty-six or 37 percent of these progeny have been confirmed scrapie at ages ranging from 22 to 65 months. These data, we believe, demonstrates that Suffolk animals from scrapie infected and source flocks if held instead of being slaughtered, will develop scrapie in significant numbers, and that scrapie will continue to occur in their offsprings born and reared on the infected premises at an even greater incidence and considerably younger average age.

Study of individual lots from infected and source flocks taken to Mission reveals that scrapie losses ranged from 0 to 57 percent of the flock. Table 2. These losses were computed directly by dividing the numbered scrapied in the lot by the total animals taken to Mission from the flock.

The next question is, “Will scrapie spread by contact to sheep of other breeds and goats?” To answer this question 140 previously unexposed sheep and goats were purchased at three to ten months of age and placed on the infected premises with a succession of scrapied sheep. The previously unexposed animals consisted of Angora and dairy goats, Hampshire, Rambouillet, Suffolk, and Targhee sheep breeds. Table 3. A study of this chart reveals that none of the previously unexposed goats brought to Mission have developed scraped. However, 29 percent of the Angora goats born at Mission and at risk have developed scrapie while 59 percent of the at risk progeny of dairy goats born there have developed the disease. In the sheep breeds, one each of the previously unexposed Hampshire, Rambouillet, New Zealand Suffolk, and Targhee have developed scrapie at rather advance ages. Indicating that animals receiving their initial exposure some months after birth either do not go on to develop clinical scrapie or develop the disease at more advanced ages than those exposed from birth on. The percentage of scrapie occurring in the offsprings born at Mission from these previously unexposed sheep ranged from 11 percent for a small group of American Suffolk up to 43 percent for the offsprings of the New Zealand Suffolks, with the Hampshires, Rambouillets, and Targhee offsprings being rather closely grouped between. The Rambouillets affected at Mission are the only known affected Rambouillets in the United States and the Targhees the only known affected Targhees anywhere in the world.
Table 3 demonstrated conclusively that scrapie can be transmitted by contact between healthy and affected animals and more importantly that it continues to occur in the offsprings of such animals born on infected premises at consistently greater incidence.

The next question is, “At what age can animals be removed from exposure and not go on to develop clinical scrapie?” To determine the answer to this question dairy goats were removed from exposure at 6 and 20 months of age, Rambouillet, Suffolk, and Targhee sheep were removed at 4, 6, 9, and 20 months of age. Table 4 demonstrated that some sheep of all breeds removed at 20 months of age developed scrapie at the expected ages. None of the dairy goats developed scrapie, however, only one lived to the expected age of scrapie. Table 5 demonstrated that Suffolks and Rambouillets removed from exposure at 4 and 9 months of age, and dairy goats removed at 6 months developed scrapie. However, none of the Targhees removed at 4 or 9 months have developed scrapie, even though 14 of these animals are now 54 months of age. None of the sheep and goats removed from exposure at birth have developed scrapie, although 20 of these animals have reached 42 months of age and 11 have reached 54 months of age. These studies are continuing. These studies demonstrate that exposed animals sold from infected and source flocks must be traced and destroyed or they will continue to develop scrapie, provide foci for continued exposure, and spread of the disease.

We believe that the study of scrapie in field outbreaks and at Mission, Texas support the present requirements of the eradication program and clearly indicate that if scrapie is to be controlled and eventually eradicated, the present policy of destroying infected and source flocks, exposed animals sold from these flocks, and bloodline animals descending from the ewe must be vigorously carried out to prevent the continued spread of scrapie within the affected breeds, and the extension of the disease into breeds not now affected in the United States.

Another concern of the United States Department of Agriculture regarding scrapie in sheep and goats is its striking similarity of clinical signs, primary histological lesions of the brain, and the biological and physical characteristics of the agent of scrapie of sheep and goats, transmissible mink encephalopathy (TME) of mink, kuru, and Creutzfeldt-Jakob disease of man. Scrapie has not been directly linked to human disease; however, the evidence continues to draw closer and closer the possibility of human health hazard. Scrapie virus inoculated into Rhesus, Cynomolgus, spider, or squirrel monkey produces a disease similar in clinical signs and brain damage to that produced by the viruses of TME and the human diseases of kuru and Creutzfeldt-Jakob disease when inoculated into monkeys.
The significance of these "slow viral diseases" was particularly emphasized in October 1976 when Dr. D. Carleton Gajdusek of the National Institute of Health, Bethesda, Maryland shared the honor of being awarded the Nobel Prize for medicine and physiology. Dr. Gajdusek and his colleagues have established that scrapie, and TME, and two human diseases have much in common. This work is characterized as a major breakthrough and discovery that has revolutionized thinking about a group of neurological diseases of previously unknown etiology.

It is worthy of note that some of Dr. Gajdusek's experiments are being conducted at Mission, Texas, in cooperation with Scrapie Field Trial personnel.
SCRAPIE
TISSUES FROM WHICH VIRUS DEMONSTRATED

NERVOUS SYSTEM
- BRAIN - CEREBRUM
- CEREBELLUM
- FRONTAL CORTEX
- MIDBRAIN
- MEDULLA
- CEREBRO SPINAL FLUID
- SPINAL CORD - CERVICAL
- SPINAL LUMBAR
- SCIATIC NERVE

MUSCULAR SYSTEM
- MUSCLE

EXCRETORY SYSTEM
- KIDNEY

REPRODUCTIVE SYSTEM
- UTERUS
- FETAL MEMBRANE

RESPIRATORY SYSTEM
- LUNG

DIGESTIVE SYSTEM
- SALIVARY GLAND
- LIVER
- INTESTINAL WALL

ENDOCRINE SYSTEM
- ADRENAL GLAND
- Pancreatic Gland
- THYMUS GLAND
- PITUITARY GLAND

RETICULO-ENDOTHELIAL SYSTEM
- BONE MARROW
- SPLEEN
- LYMPHATICS

CIRCULATORY SYSTEM
- BLOOD SERUM
Figure 2
SCRAPIE ERADICATION PROGRAM

1. LABORATORY DIAGNOSIS OF DISEASE
2. QUARANTINE OF INFECTED FLOCKS
3. TRACING
4. DISPOSITION OF:
   INFECTED FLOCKS
   SOURCE FLOCKS
   BLOODLINE ANIMALS
   EXPOSED ANIMALS
5. INDEMNITY
6. FIELD TRIAL STUDY
SCRAPIE OUTBREAKS FY 1953-1976*

SCRAPED FLOCKS U.S.A.
CHEVIOT 10
HAMPshire 2
MONTADALE 2
SUFFOLKS 199
CROSSBREED 1
TOTAL 214

*1947 Outbreak not Listed

U.S. DEPARTMENT OF AGRICULTURE
VETERINARY SERVICES
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
## TABLE 1
SCRAPIE - FATE OF PREVIOUSLY EXPOSED SUFFOLK SHEEP BROUGHT TO MISSION AT VARIOUS AGES, AND THEIR PROGENY BORN AT MISSION

<table>
<thead>
<tr>
<th>NO. AT RISK</th>
<th>NO. FREE</th>
<th>SCRAPIED</th>
<th>NO.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>315</td>
<td>224</td>
<td>92</td>
<td>29</td>
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</table>

<table>
<thead>
<tr>
<th>NO. AT RISK</th>
<th>NO. FREE</th>
<th>SCRAPIED</th>
<th>NO.</th>
<th>%</th>
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<tbody>
<tr>
<td>395</td>
<td>289</td>
<td>146</td>
<td>37</td>
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<table>
<thead>
<tr>
<th>AGE SCRAPIED (MONTHS)</th>
<th>MIN.</th>
<th>AV.</th>
<th>MAX.</th>
</tr>
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<tbody>
<tr>
<td>23</td>
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<td>142</td>
</tr>
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<table>
<thead>
<tr>
<th>AGE SCRAPIED (MONTHS)</th>
<th>MIN.</th>
<th>AV.</th>
<th>MAX.</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>40</td>
<td></td>
<td>65</td>
</tr>
</tbody>
</table>
### Incidence of Scrapie in Sheep from Infected and Source Flocks Taken to Mission, Texas

<table>
<thead>
<tr>
<th>Flock of Origin</th>
<th>Breed</th>
<th>Number of Sheep in Flock</th>
<th>Months of Study</th>
<th>Percentage of Scrapie Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infected</td>
<td>Cheviot</td>
<td>39</td>
<td>7</td>
<td>21</td>
</tr>
<tr>
<td>Source</td>
<td>Suffolk</td>
<td>101</td>
<td>69</td>
<td>57</td>
</tr>
<tr>
<td>Infected</td>
<td>Suffolk</td>
<td>44</td>
<td>82</td>
<td>20</td>
</tr>
<tr>
<td>Source</td>
<td>Suffolk</td>
<td>31</td>
<td>100</td>
<td>25</td>
</tr>
<tr>
<td>Infected</td>
<td>Suffolk</td>
<td>4</td>
<td>107</td>
<td>39</td>
</tr>
<tr>
<td>Source</td>
<td>Suffolk</td>
<td>7</td>
<td>78</td>
<td>25</td>
</tr>
<tr>
<td>Infected</td>
<td>Suffolk</td>
<td>38</td>
<td>105</td>
<td>0</td>
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<tr>
<td>Source</td>
<td>Suffolk</td>
<td>19</td>
<td>117</td>
<td>28</td>
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<tr>
<td>Infected</td>
<td>Suffolk</td>
<td>35</td>
<td>102</td>
<td>14</td>
</tr>
<tr>
<td>Source</td>
<td>Suffolk</td>
<td>9</td>
<td>68</td>
<td>5</td>
</tr>
<tr>
<td>Infected</td>
<td>Suffolk</td>
<td>19</td>
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<td>11</td>
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</tbody>
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Table 2
<table>
<thead>
<tr>
<th>BREED</th>
<th>NO. EXPOSED</th>
<th>SCRAPED NO.</th>
<th>SCRAPED AGE</th>
<th>NO. AT RISK</th>
<th>NO. FREE</th>
<th>SCRAPED NO.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANGORA GOAT</td>
<td>11</td>
<td>-</td>
<td>-</td>
<td>21</td>
<td>15</td>
<td>6</td>
<td>29</td>
</tr>
<tr>
<td>DAIRY GOAT</td>
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<td>-</td>
<td>-</td>
<td>63</td>
<td>26</td>
<td>37</td>
<td>59</td>
</tr>
<tr>
<td>RAMBOUILLET</td>
<td>31</td>
<td>1</td>
<td>88</td>
<td>95</td>
<td>80</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>TARGHEE</td>
<td>31</td>
<td>1</td>
<td>89</td>
<td>83</td>
<td>65</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td>HAMPSHIRE</td>
<td>33</td>
<td>1</td>
<td>89</td>
<td>22</td>
<td>18</td>
<td>4</td>
<td>18</td>
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<tr>
<td>SUFFOLK (U.S.)</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>9</td>
<td>8</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>SUFFOLK (N.Z.)</td>
<td>20</td>
<td>1</td>
<td>73</td>
<td>16</td>
<td>10</td>
<td>6</td>
<td>43</td>
</tr>
<tr>
<td>TOTAL</td>
<td>140</td>
<td>4</td>
<td></td>
<td>309</td>
<td>216</td>
<td>87</td>
<td>28</td>
</tr>
<tr>
<td>BREED</td>
<td>NUMBER REMOVED</td>
<td>NUMBER STILL ALIVE AND AGE (YEARS)</td>
<td>SCRAPIE (MONTHS OF AGE)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>---------------</td>
<td>---------------</td>
<td>-----------------------------------</td>
<td>--------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suffolk</td>
<td>20</td>
<td>2' 1' 5</td>
<td>28-29-33-36 40-45-51</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rambouillet</td>
<td>10</td>
<td>1' 1' 4</td>
<td>35-37</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Targhee</td>
<td>9</td>
<td>5</td>
<td>39-45-51</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goats</td>
<td>5</td>
<td>1' 1' 15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>44</td>
<td>3' 1' 2' 15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1' = DEAD NOT SCRAPIE
<table>
<thead>
<tr>
<th>MONTHS OF AGE</th>
<th>BRED</th>
<th>NUMBER REMOVED</th>
<th>NUMBER STILL ALIVE (YEARS)</th>
<th>SCRAPIED (MONTHS OF AGE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>SUFFOLK</td>
<td>18</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>&quot;</td>
<td>RAMBOUILLET</td>
<td>7</td>
<td>1'</td>
<td>1'4</td>
</tr>
<tr>
<td>&quot;</td>
<td>TARGHEE</td>
<td>8</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>GOATS</td>
<td>10</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>SUFFOLK</td>
<td>20</td>
<td>2'</td>
<td>3'</td>
</tr>
<tr>
<td>&quot;</td>
<td>RAMBOUILLET</td>
<td>9</td>
<td>1'</td>
<td>5</td>
</tr>
<tr>
<td>&quot;</td>
<td>TARGHEE</td>
<td>10</td>
<td>2'</td>
<td>8</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>82</td>
<td>3'</td>
<td>7'</td>
</tr>
</tbody>
</table>

1' = DEAD NOT SCRAPIE
REPORT OF THE COMMITTEE OF SHEEP AND GOATS

Chairman: F. James Schoenfeld, Salt Lake City, UT
Co-Chairman: C. C. Beck, Manchester, MI


The above Committee Members were in attendance. We had four guests present, totaling 17.

The Committee met as requested by the President of USAHA to consider the business of the Committee and submit the following report.

Dr. Howard W. Whitford presented a paper pertaining to the problems of Angora Goats in Texas which includes Low Kid Crop, area of infectious diseases, parasitic problems, nutrition and the role of genetics. The complete text of the paper by the personnel of the Texas Agricultural Experiment Station and Texas Agriculture Extension Service is enclosed (Enclosure 1).

Dr. T. Lynwood Barber reported on the updating of Bluetongue typing. There are 4 sero-types in the United States. Type 17 is a new one in the U. S. In 1975 Dr. Barber correlated with other sera types in the world. All Bluetongue sero-myping is done at the USDA Laboratory in Denver.

A discussion of Bluetongue was directed among the Committee:

Dr. Klingsporn said that Bluetongue is still a great concern.

Dr. Hall indicated that more work needs to be done to include the various sero-types in the vaccine.

Mr. Olin H. Timm spoke concerning Bluetongue.

Dr. Hugh Metcalf gave a brief report on the death of 500 antelope in Wyoming due to Bluetongue. The virus is now being typed at the Denver Laboratory. He also reported losses of White Tailed deer and sheep in Montana.

Dr. A. L. Klingsporn gave an update on the Bluetongue testing done during fiscal year 1976. (See enclosure 2). He also gave a report of Scrapie activities during the past year (See enclosure 3).

In connection with Bluetongue and Scrapie the Committee discussed movements of sheep to Canada.

Dr. Richard F. Hall, a member of this Committee and Chairman...
of the Biologics Committee spoke concerning the "Low Volume Drugs" which are essential and vital to the industry. It is imperative that we seek the support of the sheep and goat industry, as well as the cattle and dairy industries to work with Agricultural and Congressional Committees to help and to fund this vital Low Volume vaccine and pharmaceuticals.

Mr. Major Huff was asked to speak to this subject as an industry member.

Dr. Hall also reported that Korlan 2 Pour On has been approved for sheep, and a federal license has been issued.

The Committee discussed Anaplasmosis as it pertains to sheep. It recommends that more extensive work be done on the CF Test to make it a more accurate test for sheep.

Dr. Guy Reynolds reported on Foot-Rot Development at the Oregon Station. He said that six strains of the organism have been isolated.

Mr. Olin Timm reported on the development of the vaccine in California.

The Committee again wishes to bring to the attention of the Executive Committee, VS, and ARS, the resolution concerning funding for Foot Rot research at the Oregon Station (See enclosure 4).

Dr. Reynolds proposed to the Committee and it was approved by the Committee that we support the 172 page proposal of the National Feed Manufacturers to the FDA to clear the use of Selenium for the use in ruminant animals. This could be a great help in the control of white muscle disease.

Dr. Hall brought to our attention the work being done by Dr. Norman Gates at the DuBois Station in Idaho, with the "Thin Ewe Syndrome." He also said work is being done in Ram Epiolidymitis as to the organism, actinobacillus, being the problem rather than Brucellosis. They are developing an antogenious vaccine to use in young rams.

The Committee agreed that we need to work more closely with the industry by contributing to their publications.

The business of the Committee being completed was adjourned and we submit this report for the Executive Committee approval.

ENCLOSURE #1

TO: Health and Product Development Committee of the Texas Sheep and Goat Raisers Association
FROM: Personnel of the Texas Agricultural Experiment Station and Texas Agricultural Extension Service; Chairman—Dr. Maurice Shelton, Dr. Ed Huston, Dr. C. H. Livingston, Jr., and Dr. Howard W. Whitford of the Texas Veterinary Medical Laboratory

SUBJECT: Report and Recommendations Concerning the Problem of Low Reproductive Efficiency in Angora Goats

Low reproductive efficiency of Angora goats has long been considered the norm for Angora goats. Statistics are not available, but frequently expressed figures for long term averages for kid crops are in the range of 40-50 percent. However, individual flocks do at times approach 100%, indicating that poor kid crops are not mandatory with this animal. Thus it is both logical and timely to ask why this disparity between the potential and realized kid crops and what can be done to correct it. Reference has been made to unusually poor kid crops (as low as 20%) in recent years. We have no direct information to confirm or to explain this deterioration in reproductive efficiency. However, we have no reason to or intent to question producer reports in this regard.

Reproductive failure may result from:

(a) A failure to show estrus or to ovulate within the breeding season
   This is almost entirely explained by a lack of size and development

(b) Failure of conception
   Among healthy, well developed does, this would be largely explained by a failure of the males to rut or to provide adequate service

(c) Abortion or resorption of the embryos
   The losses from abortion is highly variable and may range from zero to a high proportion in Angora flocks. The explanation for abortion is too complex to attempt at this point.

(d) Death loss of kids produced
   Death losses are usually explained by starvation (which in itself may have many explanations), cold stress or predators.

Individual flocks may experience losses from none or all of these causes. Those producing good kid crops usually evade serious losses from any, whereas, problem flocks may experience losses from all these causes.

Comments on Possible Causes of Low Reproductive Efficiency

Infectious and Parasite Diseases:

Infection has not been identified as a major cause of loss in
reproduction in goats. With other species of livestock, brucellosis, vibriosis and leptospirosis are diseases associated with reproductive failure. In the past, efforts have been made to identify these diseases entities as a cause of loss in goats without success. Also the nature of the losses does not suggest infection as the primary cause. However, this may not be true and Dr. Livingston, in cooperation with the Veterinary Diagnostic Laboratory, will continue to investigate cases of loss which are brought to their attention from experimental or producer owned flocks. Aborted fetus, placental membranes and material obtained from aborting nannies will be examined for agents not routinely cultured in the diagnostic laboratories i.e. ureaplasma, mycoplasma and acholeplasma, L-Form of bacteria. Through serological and cultural studies they will survey the Angora goat population for evidence of disease which may be associated with poor reproduction. If disease is identified as a major contributing factor efforts will be directed to means of alleviating the problem. Angora goats are probably more susceptible to internal parasites than any species of farm or ranch livestock. The primary problem is gastrointestinal nematodes and coccidiosis. Neither of these have a specific effect on reproduction, but they are major factors affecting general health and development of the goat. Thus they can indirectly have an important effect on reproduction.

Recommendations:

1. In the absence of information indicating disease as a major source of loss, no recommendations can be made relating to preventing loss from disease. Producers are encouraged to be on the alert for suspected cases of loss from disease and to call this to the attention of their veterinarian, County Extension Agent or Dr. C. W. Livingston at the San Angelo Research & Extension Center or Texas Veterinary Medical Diagnostic Laboratory at College Station.

2. Producers are also encouraged to become familiar with the problem of internal parasites, especially coccidiosis, and develop management systems for dealing with this problem.

3. Consideration should be given to petitioning the Food and Drug Administration to allow any drug which has been approved for sheep to be used with goats. If specific research is required to convince the FDA of the safety of this approach the requirements should be spelled out; efficacy, residue, warning on labels, safety.

Genetics:

In a broad sense, the reproduction problems of the Angora are inherited to the extent that it is a problem with Angora and not with Spanish goats and the difference between these types is genetic. However, there is not a good reason to think that the fertility prob-
lem is due to any single gene or simple gene combination. First, nature itself tends to eliminate genes contributing directly to infertility from the population as infertile animals do not leave replacements or contributions to future generations. Also by analogy with other species of breeds of livestock, the heritability of fertility is very complex in nature. Also, producers have alluded to a deterioration in fertility in recent years, and there is no way that a significant genetic change can be effected in a large population in the equivalent of one animal generation. Thus we feel strongly that in a short term view and in a restricted sense, inheritance is not the explanation for a deterioration in kid crops. However, in a long term view, inheritance is the primary explanation in that the phenomenal success in breeding for mohair production has resulted in an animal which is poorly adapted to the environment in which they are produced. A highly selected Angora goat produces fiber at the rate of two to four times that of our better producing sheep. This high level of fiber production has resulted in an unusually high nutrient requirement for a small animal with a limited foraging capacity or capability. Also the weight of the mohair can be a burden on the animal as well as interfere with foraging. Only mutton goats, which do not have the burden of reproduction, are able to maintain themselves in a vigorous state without good range conditions or considerable assistance from man. Even Angora muttons do not become fat as a steer and a dry ewe would do.

Just as short term genetic change cannot be used to explain a deterioration in fertility, selection cannot be relied upon to provide a quick solution to the problem. However, over a long period of time selection provides the only reliable means of alleviating the problem.

Researchers in South Africa have suggested that selection for fine hair has resulted in an abnormal adrenal status which contributes directly to abortion and indirectly to other problems. We cannot confirm or deny that this is the case, but it seems unlikely that there has been any precipitous change in hair quality or in the genotype of Texas goats in respect to fiber diameter. Reproductive problems have been a problem for a long period of time with the Angora and abortion, although prevalent, has not been identified as the major source of the problem in Texas. Abnormal adrenal status or response to stress appears to be common with Angora, but this appears to be merely the mechanism of interrupted reproduction and not the basic cause. Although selection for fine hair does not appear to offer an explanation, selection for heavy mohair production, complete covering and high oil content are no doubt important problems. Poor breeders are almost invariably those that shear a heavy clip of mohair in respect to their size, but may not be heavier shearing on a per head basis.
Recommendation:

1. At a time of high mohair prices and scarcity of numbers, the culling to slaughter, of goats because of poor reproduction would appear to be poor judgment. Does which might be culled on reproductive efficiency could well be kept for hair production alone. Also any net kids raised out of these does would contribute to numbers in the industry. What would appear to be more important would be to insure that males are not kept from any does with a poor reproductive history. Where numbers permit culling previously dry or aborter does, very small, wooly faced does and does with bad udders are good candidates for culling.

2. The design of appropriate selection programs should have a high priority for the future. The high nutritive requirements of the Angora goat places the breeder, especially the stud breeder, in a quandary. If the goats are not provided with good nutrition they will not develop adequately to be selected and successfully used as breeders. However, this practice contributes to the problem of breeding an animal which is poorly adapted to his environment.

Culling of does may make an immediate improvement in kid crop for those remaining, but it will make little genetic change in the population. Also extensive culling of the females is possible only when a surplus exists. Genetic change can only be accomplished through male selection.

Selection for size, with both sexes, is the easiest to implement and will give positive results. However, more long term improvement in fertility will result from using some type of records on reproductive performance as an adjunct to size.

Nutrition:

Nutrition is thought to be the major direct cause of poor reproduction. However, genetics is the predisposing factor in having developed an animal with a higher requirement than can be satisfied under most typical range conditions. Thus the producer is faced with one or a combination of the following choices.

1. Improve the animals environment by utilization of cultivated harvested feeds
2. Breed an “easy care” animal which is better adapted to the conditions under which it is to be raised
3. Be prepared to accept low kid crops and associated problems/or
4. A combination of the above

Which of the above courses of action to be chosen would depend
in a large part on what the producer believes the income picture to be for this industry. At current prices, the immediate choice should be clear in that the animals should be cared for in a manner to maximize their production. However, if history can be taken as a prologue to the future, prices will be erratic or variable and the prices received will not always justify the cash costs of improving the animals environment to the extent that good performance can be expected. This would indicate that simultaneous and immediate goals should be to breed an “easy care” animal.

Recommendation:

Since supplemental feed is supplied to “supplement” pasture or range vegetation it is necessary to consider what vegetation is available, what it supplies and when before supplemental feed needs can be determined. Therefore it is crucial that the producer become familiar with the plant species on his range and what the goat is consuming. For example, if a range has a scattering of a wide variety of plant species including winter growing plants such as scattered liveoak and juniper, Texas wintergrass and Canada wildrye, good conditions and warm winter days bring on desirable annual forbs such as filaree and tallow weed and goats are fairly well fed. Research shows that periods of deferment in systematic grazing programs will encourage such diversity. Most spring plants supply adequate nutrients for Angora goats. The better goat pastures will have scattered prickly ash, elbow bush, shin oak, hackberry and other deciduous browse plants to supplement summer and fall grasses. Only the growing kid and yearling appear to need extra nutrition from April to November if the rangeland has a good variety. A mixture similar to the following should be fed to kids free choice and to developing yearlings at a rate of about $\frac{1}{4}$ pound per day during the period of July thru November.

Developing Ration For Kids & Yearlings On Rangeland

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cottonseed meal</td>
<td>50</td>
</tr>
<tr>
<td>Sorghum grain</td>
<td>45</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>5</td>
</tr>
<tr>
<td>Vitamin A—5000 I.U. per lb.</td>
<td></td>
</tr>
</tbody>
</table>

The developing kids and yearlings as well as older breeding does might be fed from about December 1 until spring at a rate of about $\frac{1}{2}$ to $\frac{3}{4}$ pounds per day of the following mixture.
### Winter Supplement For Developing & Breeding Angora Goats

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cottonseed meal</td>
<td>75</td>
</tr>
<tr>
<td>Sorghum grain</td>
<td>23</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>2</td>
</tr>
<tr>
<td>Vitamin A—5000 I.U. per lb.</td>
<td>100</td>
</tr>
</tbody>
</table>

The condition of the animal is the key to the level of nutrition and may be taken as a guide to the adequacy and suitability of the ration suggestions.

**Research Needs:**

The Texas Agricultural Experiment Station should be encouraged to establish breeding flocks of Angora does at either or both Hill Ranches (between Sonora and Rocksprings) and the Winters Ranch at Brady, to monitor reproductive problems with goats and to investigate ration formulation, methods and levels of supplemental feeding on reproduction goats.

**Management During Kidding:**

It would appear that management during kidding was a likely contributing factor to low net kid crops for the past season. The possibility presents itself that producers overestimated the range condition last fall and failed to prepare their animals by feeding in advance of kidding. Realizing the high value of the kid crop, it seems possible that they attempted to feed, possibly even hand feed, during kidding, with considerable disruption of kidding or interfering with kid survival.

No totally satisfactory method of feeding during kidding has been developed. As of the present, and in the absence of a better suggestion, the use of salt as a feed limiter seems to be indicated. A compromise between hand feeding and the use of salt as a limiter is to feed a low salt feed (such as 15%) in the amounts desired. This can be done at irregular intervals, usually without disrupting kidding. This approach can cause the does to spend a lot of time trailing back and forth to the feed trough. If in large pastures, this can create problems. For this reason, it is preferable that kidding be done in small pastures or traps where feasible.
Research should be directed toward development of a more satisfactory feed limiter or methods of feeding distribution for use with goats and sheep, especially during kidding or lambing.

**General Recommendations:**

1. Producers should take advantage of the present favorable price situation to provide adequate care (largely through feeding) to maximize current kid crop and to develop future breeding stock for maximum future production.

2. When feasible, consider kidding under confined conditions to salvage the maximum number of kids.

3. Initiate changes in the breeding program which are designed to develop animals which will be better adapted to production conditions and which are not subject to reproductive failure.

4. Develop improved methods of controlling internal parasites, especially coccidiosis, to eliminate the adverse effects on growth and survival of young kids.

5. Initiate immediately research programs to provide better recommendations on ration formulation and methods of supplemental feeding.

6. Initiate broad scale survey studies to pinpoint more specifically the nature of the losses on reproduction and determine the underlying causes. (Specific work plans will be prepared in which producer assistance in this matter may be requested)

7. Continue monitoring the population for evidence of infectious diseases that might contribute to the problem.

**ENCLOSURE #2**

**BLUETONGUE**

During fiscal year 1976 (July 1, 1975, through June 30, 1976) bluetongue was confirmed by virus isolation in two cattle herds, one each in Colorado and Louisiana; and in six sheep flocks, two in California, two in Texas, and one each in Idaho and Oklahoma. During the same period, epizootic hemorrhagic disease (EHD) virus was isolated from three deer, two in Indiana and one in New Jersey.

In addition, 41,946 modified direct complement-fixation (MDCF) tests were run at Veterinary Services Laboratories, Ames, Iowa, and at 14 approved laboratories with the following results:
REPORT OF THE COMMITTEE

<table>
<thead>
<tr>
<th>Total Tested</th>
<th>Negative</th>
<th>Suspicious</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>37,734</td>
<td>32,833</td>
<td>3,886</td>
</tr>
<tr>
<td>Goats</td>
<td>445</td>
<td>422</td>
<td>19</td>
</tr>
<tr>
<td>Sheep</td>
<td>854</td>
<td>627</td>
<td>119</td>
</tr>
<tr>
<td>Wildlife</td>
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<td>30</td>
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<td>2,697</td>
<td>2,690</td>
<td>7</td>
</tr>
<tr>
<td>Totals</td>
<td>41,946</td>
<td>36,738</td>
<td>4,061</td>
</tr>
</tbody>
</table>

Positive MDCF samples were collected from the States of Arizona, Arkansas, California, Florida, Georgia, Idaho, Iowa, Louisiana, Missouri, Montana, Nebraska, Nevada, New Jersey, New York, Ohio, Oklahoma, Oregon, Texas, Utah, Virginia, Washington, Wisconsin, and Wyoming.

ENCLOSURE #3
SCRAPIE

Scrapie was reported in five flocks in Illinois, New York, Oklahoma, Pennsylvania and West Virginia during fiscal year 1976 (as of June 30, 1976-) The Illinois outbreak occurred in a Hampshire flock in LaSalle County, the New York outbreak in a Suffolk flock in Pottawatomi County, the Pennsylvania outbreak in a Suffolk flock in York County, and the West Virginia outbreak in a Suffolk flock in Pendleton County. There were three outbreaks reported in fiscal year 1971, four in 1972, two each in 1973, 1974, and 1975, and five in 1976. The number of flocks under surveillance have only decreased from 116 to 112; however, this number will increase when tracing from 1976 outbreaks has been completed. Eradication efforts for scrapie have been encouraging over the past years; however, the disclosure of five outbreaks during 1976 demonstrates that the disease is not eradicated and that there must be no letdown in carrying out all phases of the program if we are to eradicate this disease.

The Illinois outbreak was reported by the owner; the New York and West Virginia outbreaks were discovered during routine surveillance inspections; the Pennsylvania outbreak was disclosed by back-tracing from the West Virginia infected flock; and the Oklahoma outbreak was disclosed when the owner took the infected ewe to Oklahoma State University for diagnosis. All infected flocks have been slaughtered and regulatory officials have endeavored to locate and slaughter all exposed and certain bloodline animals sold from these flocks. The source of the Illinois and Pennsylvania outbreaks has not been determined; the New York outbreak had its source from a Massachusetts flock, which was also the source of two New Jersey outbreaks; the source of the West Virginia outbreak was the Pennsylvania infected flock; and the source of the Oklahoma outbreak was
an Illinois flock. The source flocks for New York and West Virginia infected flocks has been slaughtered and regulatory officials are endeavoring to locate and slaughter exposed and certain bloodline animals sold from these flocks. The Illinois source flock (for the Oklahoma outbreak) has not been slaughtered and is being held under State and Federal quarantine. A list of sales from this flock has not been obtained.

The August 27, 1975, 9 CFR, Part 54, was amended to require: The slaughter of exposed sheep and goats as well as bloodline animals; the disposal of their carcasses by burning or burial and prohibit the meat from slaughtered animals being salvaged for human or animal food; and compensate owners for loss of salvage by increasing maximum Federal Indemnity to $40 for grade animals and $90 for purebred animals. These amendments have reduced the possible human and/or animal health hazard from scrapie.

Effective November 13, 1974, a Federal quarantine had been placed on De Kalb County, Illinois, infected flocks and lifted April 23, 1975, after slaughter of infected and exposed sheep had been completed.

Effective August 31, 1976, a portion of La Salle County, Illinois, was placed under Federal quarantine due to a source flock being located there. A Suffolk ewe was showing clinical signs of scrapie 2 months after being moved from the Illinois flock into an Oklahoma flock.

Members of the Illinois Sheep Breeders Association have requested a national meeting to review scrapie and the Cooperative Scrapie Eradication Program. Veterinary Services will contact industry associations and other interested individuals to determine their interest in such a meeting and to solicit their participation.

SCRAPIE FIELD TRIAL*

The scrapie field trial has been underway since November 1964 (142 months). During this period, natural scrapie has been confirmed by histopathological study or by mouse inoculation in 349 sheep or goats.

The findings demonstrate that animals from infected and source flocks will develop scrapie at high incidence if not slaughtered. The findings also demonstrate that scrapie can be transmitted to previously unexposed sheep and goats held and bred on infected premises in contact with scrapie-affected sheep and goats. Therefore, scrapie has the potential to cause considerable loss within a flock and breed. These statements are supported by the following data:

*Misson, Texas
1. Of 315 Suffolk sheep at risk taken to Mission from infected and source flocks, 92 (29 percent) have developed scrapie. Of their 395 progeny born at Mission, 146 (37 percent) developed scrapie.

2. Only 4 of 123 previously unexposed sheep brought to Mission developed scrapie; however, of their 309 progeny at risk, 87 (28 percent) were scrapied.

3. Progeny of Suffolk sheep born at Mission developed scrapie at rates varying from 24 percent when both parents were scrapie free to 80 percent when both parents were scrapied.

4. None of the previously unexposed Angora or dairy goats taken to Mission developed scrapie; however, of their progeny born at Mission and at risk, 6 (29 percent) of the Angora goats and 37 (59 percent) of the dairy goats have developed scrapie.

5. Progeny of dairy goats born at Mission developed scrapie at rates varying from 43 percent when both parents were scrapie free to 100 percent when both parents were scrapied.

6. Goats, Suffolks, and Rambouillots (but not Targhees to date) developed scrapie if born on infected premises and removed from exposure at the following ages: Goats at 6 months, Suffolk at 4 and 9 months, and Rambouillots at 4 and 9 months.

Scrapie has not been directly linked to human disease; however, the evidence continues to draw closer and closer the possibility of the human health hazard. Scrapie virus inoculated into Rhesus, Cynomolgus, spider, or squirrel monkey produces a disease with similar symptoms and brain damage as that produced by the viruses of transmissible mink encephalopathy (TME) and of the human diseases of kuru and Creutzfeldt-Jakob disease (when inoculated) into monkeys.

The significance of these "slow viral diseases" was particularly emphasized in October 1976 when Dr. D. Carleton Gajdusek of the National Institute of Health, Bethesda, Maryland, shared the honor of being awarded the Nobel Prize for medicine and physiology. Dr. Gajdusek and his colleagues have established that scrapie and TME of mink and two human diseases have much in common. This work is characterized as a major breakthrough and discovery that has revolutionized thinking about a group of neurological diseases of previously unknown etiology.

It is worthy of note that some of Dr. Gajdusek's experiments are being conducted at Mission, Texas, in cooperation with Scrapie Field Trial personnel.
STATUS OF THE STATE-FEDERAL HOG CHOLERA ERADICATION PROGRAM

S. H. Young, DVM and J. W. Walker, DVM, MPA

Fiscal year 1976 has been somewhat of a disappointment for the State-Federal Hog Cholera Eradication Program. Almost everyone had anticipated the United States would be declared hog cholera free in 1976. Following the rather extensive outbreak resulting in 163 cases in several States in FY 1973, the incidence of infection was reduced to 2 cases in FY 1974. One of these was confirmed in Mississippi and the other in Puerto Rico.

When hog cholera was not confirmed in FY 1975 and Great Britain permitted the importation of pork from the United States, many concluded the goal of eradication had been achieved. Plans for an appropriate celebration had become a major consideration.

TEXAS BREAK-FISCAL YEAR 1976

The first disappointment came within the first 4 days of FY 1976, when hog cholera was confirmed in Texas on July 4, 1975. Two related cases were confirmed in Texas. An additional 22 herds in Texas and 6 herds in Oklahoma were depopulated as exposed.

The export market to Great Britain was promptly lost following the Texas break. It has been estimated this represented a $15 million loss to the swine industry in FY 1976.

A conclusive source for the Texas break was not established. Many concluded the outbreak had been introduced from Mexico. Most chose to disregard the fact that the break in the Panhandle of Texas was several hundred miles from the Mexican border and that the infection had been there for a minimum of 2 months before it was disclosed. Aside from the immediate task force operation, little increase in surveillance resulted from the Texas break.

PROGRAM CHANGES

At the time of the Texas break, the Federal regulation was changed to permit total payment of indemnity for swine destroyed because of hog cholera from Federal funds.

Because of the extended period without a case prior to the Texas break, the recommended surveillance period, as part of the requirement for free status, was reduced from 18 months to 12 months.

The phase status that permitted each State to individually move

Prepared by Swine and Poultry Diseases Staff, Veterinary Services, APHIS, USDA, November 1976.
ahead in the program no longer served a useful purpose, and references to phases were discontinued. An infected area is presently that area placed under State-Federal quarantines, and the area returns to free status when the quarantine is removed.

NEW JERSEY AND NEW ENGLAND OUTBREAK-FISCAL YEAR 1976

The second outbreak of hog cholera in FY 1976, was first confirmed in New Jersey on February 24, 1976. This was promptly followed by confirmation of infection in Rhode Island, Massachusetts, and New Hampshire. This outbreak has resulted in the depopulation of 10 confirmed and 19 exposed herds in New Jersey, 6 confirmed and 22 exposed herds in Massachusetts, 1 confirmed and 2 exposed herds in New Hampshire. A total of 24,038 swine were depopulated, involving $2,933,558 in indemnity. Emergency operation costs, excluding the continued increased surveillance in the area and the increased surveillance in other parts of the country, resulted in an additional expenditure of approximately $2.2 million. The last positive case was confirmed on August 1, 1976.

EPIDEMIOLOGY OF NEW JERSEY AND NEW ENGLAND OUTBREAK

This outbreak has essentially involved waste feed operations, but there is no supportive evidence that the source of the outbreak was through garbage. Serological evidence, along with the actual disclosure of outdated hog cholera vaccines, is supportive evidence that the infection resulted from the use of vaccines. These were products stored prior to the restrictions on the interstate movement of vaccines in 1969. There was no evidence suggesting the use of vaccines in New Jersey. Epidemiological studies support the theory that infection had existed in the New England area for an extended period. New England is believed to be the source of the infection in New Jersey, but the exact method of transmitting the virus was not established. Most swine movements from the New England area are toward the New Jersey area, and the same markets are also used by New Jersey producers.

SURVEILLANCE

Continued surveillance is essential to assure completion of the hog cholera eradication program. The charts showing surveillance activities indicate a rather substantial increase over FY 1975. Unfortunately, all of the increase has resulted from task force activities in the known infected areas. The chronic nature of the remaining hog cholera virus is such that it can apparently remain active in a herd for as long as a year or more without producing substantial
death losses. In addition, experimentally infected animals have been demonstrated to continue to shed virus for periods exceeding 3 months. The extensive surveillance activities by the task force operations were not sufficient to assure disclosure of all the infection on two occasions. It is essential that all areas of the country continue hog cholera surveillance. If this type of virus does not exist in other areas, undoubtedly a considerable amount was distributed through meat products sold prior to the time quarantines were imposed. Hog cholera free status is near, but it may still require some continued effort for realization. (Figure 1, Figure 2, Table 1, and Table 2)
HOG CHOLERA CASES REPORTED

By Fiscal Year

<table>
<thead>
<tr>
<th>YEAR</th>
<th>NUMBER CASES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1967</td>
<td>7,200</td>
</tr>
<tr>
<td>1969</td>
<td>6,000</td>
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<tr>
<td>1971</td>
<td>4,800</td>
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<td>1973</td>
<td>3,600</td>
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<tr>
<td>1975</td>
<td>2,400</td>
</tr>
<tr>
<td>1977</td>
<td>1,200</td>
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* Does not include Transition Quarter.

U.S. DEPARTMENT OF AGRICULTURE
VETERINARY SERVICES
ANIMAL AND PLANT HEALTH INSPECTION SERVICE

*HOG CHOLERA ERADICATION PROGRAM*
## HOG CHOLERA CASES FISCAL YEAR 1976*

<table>
<thead>
<tr>
<th>STATE</th>
<th>POSITIVE CASES</th>
<th>ANIMALS DEPOPULATED</th>
<th>EXPOSED CASES</th>
<th>ANIMALS DEPOPULATED</th>
<th>INDEMNITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas</td>
<td>2</td>
<td>218</td>
<td>22</td>
<td>2,132</td>
<td>206,017</td>
</tr>
<tr>
<td>Oklahoma</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Jersey</td>
<td>10</td>
<td>12,500</td>
<td>19</td>
<td>6,480</td>
<td>2,373,757</td>
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<tr>
<td>Massachusetts</td>
<td>6</td>
<td>1,722</td>
<td>22</td>
<td>878</td>
<td>287,708</td>
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<tr>
<td>Rhode Island</td>
<td>1</td>
<td>1,571</td>
<td>2</td>
<td>110</td>
<td>174,598</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>1</td>
<td>729</td>
<td>2</td>
<td>65</td>
<td>97,495</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
<td><strong>16,740</strong></td>
<td><strong>73</strong></td>
<td><strong>10,799</strong></td>
<td><strong>3,270,248</strong></td>
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*Includes Transition Quarter.
HOG CHOLERA SURVEILLANCE  
Fiscal Year 1976*

<table>
<thead>
<tr>
<th></th>
<th>HERDS</th>
<th>SWINE</th>
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</thead>
<tbody>
<tr>
<td>On Farm Inspections</td>
<td>143,957</td>
<td>7,869,132</td>
</tr>
<tr>
<td>Market Inspections</td>
<td>522,037</td>
<td>11,725,794</td>
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<tr>
<td>Laboratory Screening</td>
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<tr>
<td>Floresent Antibody (FA) Tests</td>
<td>6,776</td>
<td>80,317</td>
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<tr>
<td>Serum Neutralization (SN) Tests</td>
<td>3,523</td>
<td>99,153</td>
</tr>
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</table>

*Does not include Transition Quarter.
REPORT OF THE COMMITTEE ON
NATIONWIDE ERADICATION OF HOG CHOLERA

Chairman: Lowell W. Hinchman, Indianapolis, IN
Co-Chairman: J. B. Taylor, Montgomery, AL

Benedicto Negron, Don G. Brothers, E. A. Butler, George B. Estes,
J. M. Garner, R. E. Hall, J. S. Hayden, John W. Holcombe,
In-Chang Pan, C. H. Mannasmith, L. D. Marks, Ray Pyles, H. Q.
Sibley, Paul Spencer, M. J. Tillery, John Villari

The United States again approaches the threshold of being de-
clared hog cholera-free. It does so with the confidence of a veteran
warrior who has felt the elation of a successful battle, felt the pangs
and disappointment of defeat, but still retains the confidence and
knowledge that the war can be won.

The plan of battle consists of the regrouping and pursuit of
tenets and principles that have been instrumental in the successful
approach to the eradication of hog cholera, plus some new approaches
to those problems which may have contributed to stalemate and un-
successful conclusion of the campaign this last year.

The Committee recommendations for 1976 by subject are:

1. Surveillance: Continued surveillance procedures, including the
serological screen testing for hog cholera, must be given a priority
in the state and federal committees, and the strict compliance to
the guidelines established in the minimum standards of surveillance
as defined in Memorandum 561.1 must be adhered to by all state
and federal regulatory officials.

2. Tissue screening: All swine tissues submitted to state and fed-
eral diagnostic laboratories must continue to be screened by the
florescent antibody (FA) technique and irradiated, non-infective
hog cholera control tissues should immediately replace all live virus
tissues used in this diagnostic screening process.

3. Identification: The urgent need for a swine identification pro-
gram still remains to be one of the tools necessary to successfully
combat the disease of hog cholera.

4. Communication: The necessity of maintaining and increasing
direct contact with veterinary practitioners, the swine industry vo-
cational educators, news media and all interested parties becomes
more important than in previous years in an effort to maintain the
necessary level of interest and neutralize the apparent state of apathy
and complacency that exists today.

5. Vaccines: State regulatory officials should proceed to enact
legal capabilities to prevent the use of any vaccine in swine which
will deter or confuse the diagnosis of hog cholera; such enactments should prohibit the sale of ownership of hog cholera vaccine. The U.S.D.A. is strongly urged to secure the necessary legislation to make it a criminal offense to use or possess hog cholera vaccine.

6. Waste Feeding: The adequate enforcement of state laws relating to waste feeding must be maintained and the committee urges the U.S.D.A. to make funds available to further investigate, develop and improve alternative methods of feeding food waste. Since the feeding of food waste may potentially present disease problems other than hog cholera, the committee recommends that a permanent committee on Food Waste be established to study and develop guide lines for the proper disposition and use by the participants in this industry.

The committee recommends that the U.S.D.A. maintain the hog cholera eradication program in a high priority position in an effort to properly pursue the eradication and surveillance procedure necessary for the programs success.

This report is respectfully submitted to the Executive Committee of the U.S.A.H.A. for approval.
Aujeszky's Disease (pseudorabies) has been recognized throughout the world including the United States for many years. The virus is pathogenic in most species of animals with the probable exception of man but its primary host is swine. Sporadic outbreaks of clinical significance have been noted in swine in the United States but, until recently, the most dramatic losses were in cattle exposed to carrier swine. The past several years have brought a change in the expression of Aujeszky's disease in the United States with more severe clinical syndromes similar to those in intensified swine raising areas of Europe.

Clinical Significance

An example of the increasing significance of Aujeszky's disease in the midwestern United States is reflected in the number of infected herds confirmed in Iowa over the past several years. An average of about 5 cases per year were detected in Iowa from 1969 to 1974. Suddenly in 1974, the confirmed number of infected herds increased to 28. The number further increased to 60 in 1975 and approximately 186 in the first 9 months of 1976. These figures represent confirmed laboratory diagnoses and the prevalence is probably higher because the disease is becoming so common in some areas that producers and veterinarians are failing to confirm the diagnosis. Similar increases in prevalence have been reported in several other states.

The rapid increase in incidence has been accompanied by a concurrent increase in virulence. Losses have been much higher in recent outbreaks. Macroscopic lesions including necrotic foci in livers, spleens, lungs, and tonsils of affected suckling pigs have been frequently observed. The reason for changes in the disease pattern are unknown but importation of foreign strain of virus or mutation of domestic viruses have been suggested as possibilities. The suggestion that there is a relationship to the termination of hog cholera vaccination has never been supported by fact or logical argument.

Detailed descriptions of the clinical effects of Aujeszky's disease have been published. Losses in recent outbreaks have been reflected in high death loss in suckling pigs which usually have signs of central nervous system damage prior to death. Other losses are

*Department of Veterinary Pathology, Iowa State University, Ames, Iowa 50011.

**Veterinary Diagnostic Laboratory, Iowa State University, Ames, Iowa 50011.
observed in older pigs and breeding stock where the disease may be respiratory in nature. Fetal resorption, fetal mummification, abortion, and other forms of reproductive failure are often observed in pregnant sows or gilts exposed to this virus. A specific herd may experience major losses due to any or, more likely, a combination of these reproductive problems. Most herds return to normal performance after a few weeks but losses during the outbreak may be severe. A survey of 16 herds in central Iowa resulted in an estimated loss of approximately $28,900.00 per herd. One of the most difficult losses to evaluate is the restrictions being placed on movement of swine into the various states and into foreign countries. If the present trend continues, export losses could become very significant.

Control-Prevention

Prevention is the best means of controlling Aujeszky's disease since no satisfactory treatment exists. Spread from one geographic area to another occurs with movement of swine which are infected with the virus. Spread within a local area may be by other means. Some circumstantial evidence suggests that wild and domestic animals such as raccoons, foxes, dogs, or cats may be involved. Possible vectors other than swine are not well defined.

The prudent producer may take several precautions including purchase of animals from known sources and testing for antibody titers against pseudorabies virus. The serologically positive animal is a potential virus shedder and breeding stock should not be purchased from herds containing seropositive animals. Not all seropositive animals shed the virus and viral shedding is sporadic, perhaps enhanced by stressful conditions. Until some improved method of specific carrier identification is developed, all seropositive animals should be rejected.

The second precaution to be taken by the producer is to practice a closed-herd concept taking care to exclude wild animals, stray animals, and human traffic from his premises. Until better information is available, a number of potential vectors must remain suspect.

Control-Infected Herds

The first and most urgent obligation is to quarantine the herd suspected of having Aujeszky's disease. Some states have quarantine laws which restrict movement from infected herds for up to 30 days after clinical signs vanish. This is a partial aid to control since virus shedders are very numerous in the herd with clinical disease. Movement of shedders is probably greatly reduced by these quarantine procedures but the producer should be made aware that carrier
animals may persist well beyond 30 days and that there is a definite moral obligation to prevent movement of any seropositive animals.

Little can be done to reduce losses in the affected herd. Porcine origin antiserum with titers of at least 1:256 have proven effective in reducing death losses if administered to neonatal pigs. However, success has been variable in some herds with an experimental product and no commercial source of antiserum exists at present.

Antibiotic therapy in animals over 3 to 4 weeks old has proven useful in reducing secondary bacterial infections. Perhaps the greatest challenge is management of the breeding herd. If adequate isolation is available it may be wise to try to prevent transmission to various parts of the affected herd. However, some field experience suggests that it may be wise to intentionally infect non-pregnant breeding stock in commercial herds. This should be attempted only by contact with affected animals and not by the practice of feeding dead pigs which may be fatal.

Extreme care should be taken to provide maximum isolation from other livestock and pets. Aerosal exposure can occur, at least over short distances, so separation should provide some open air between groups of animals. One basis for optimism is that many commercial herds of swine have returned to normal productivity following an outbreak. Unfortunately, this is not always the case as a variety of reproductive problems and recurrences have been observed in some herds. Movement should be only to slaughter in any case until the convalescent herd can be shown to be seronegative.

**Control-Vaccination**

Modified live virus vaccines used in some parts of Europe have been successful in reducing losses. However, there is no evidence that they prevent infection or the establishment of carrier animals. Killed virus vaccines have proven less satisfactory. The obvious disadvantage to vaccination is the development of seropositive animals which would confound any epidemiological or control programs which relied on the detection of antibodies to identify pseudorabies virus exposed animals.

**Control-Eradication**

There is an urgent need to examine the feasibility of eradicating Aujeszky's disease in the United States while the number of infected herds is relatively small and endemic areas are identifiable. All available evidence suggests that, although other species may be infected, swine are the reservoir of the virus. A strong program to determine incidence and identify infected herds could be based on serologic evidence.
AUJESZKY'S DISEASE

Strict enforcement of uniform rules against movement of sero-positive animals could be followed by testing programs directed at the quarantine and slaughter of positive herds. Such a program has a good likelihood of stopping the spread of infection and ultimately eliminating foci of infection. If current incidence rates are a prediction of the future, it is imperative that procedures be initiated in the near future before the disease becomes so disseminated that it would be unmanageable.

A part of any control program based on serologic evidence is the need for restriction of vaccine usage which would produce numerous seropositive animals whose potential carrier status could not be determined. Other needs include the adoption of uniform serologic procedures and adequate support to testing laboratories so that high volume testing may be expeditiously accomplished.

REFERENCES

NEWER DEVELOPMENTS IN UNDERSTANDING
MYCOPLASMAL PNEUMONIA OF SWINE

William P. Switzer, DVM, PhD and Dan O. Farrington, DVM, PhD

With the identification of the causative agent as *Mycoplasma hyopneumoniae* over a decade ago it would seem that considerable progress should have been made toward an understanding of practical control of mycoplasmal pneumonia. Such has not been the case. One of the major reasons for the slow progress is that the organism is relatively difficult to isolate and grow. It is very difficult to isolate in pure culture when it is present in a mixed population with the more robust *Mycoplasma hyorhinis*, as it frequently is, and once grown in pure culture it is difficult to separate the *Mycoplasma hyopneumoniae* from medium components.

In spite of some of these problems there has been progress made and additional information is being developed by several different research groups. It is basic to the study of this disease that adequate techniques be developed to recognize and monitor the presence of the infection in swine herds. Since cultural detection of infected animals is not practical at this time considerable effort has been invested in development and evaluation of serological tests. The tests that appear to hold the most promise at the present time are the rapid slide agglutination of antigen coated latex particles, the indirect hemagglutination test and the microtiter complement fixation test utilizing guinea pig complement modified by the addition of normal swine serum. This latter test is proving to be a very useful research tool and is being evaluated for possible use under selected conditions in field herds.

The use of serological procedures has assisted in developing several facts concerning reliance on gross lung lesions for diagnosis of this disease. It is apparent that uncomplicated gross lesions may heal in eight to twelve weeks and leave very little gross alteration of lungs. In addition, some strains of this organism do not appear to be of adequate virulence to produce gross lesions in most of the infected pigs, but will produce typical microscopic lesions and elicit seropositive conversion. Such infections may give rise to distrust in the validity of the serologic test unless a thorough examination for microscopic lung lesions is conducted.

Application of the CF test to field herds has revealed that pigs eight to ten weeks of age infected with virulent *Mycoplasma hyopneumoniae* to produce definite clinical signs of pneumonia will usually have positive titers. Pigs of this age affected with less virulent strains will usually be test negative. In such herds affected with mild strains the animals will usually become seropositive by about sixteen weeks of age. Application of the CF test to infected herds with mild infections, that is to "normal" conventional herds.

Iowa State University, Ames, Iowa 50011

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usually indicates a peak incidence of seropositive animals in the six month to one year age range. In this group the incidence of seropositive animals will often reach sixty to sixty-five percent.

As older breeding stock is tested there is usually a steady decline in the incidence of seropositive animals until an expected twenty to twenty-five per cent rate is reached in breeding animals over thirty months of age. This is apparently due to resolution of the lesions with subsequent seronegative conversion. Such seronegative animals do not always remain negative and may undergo episodes of seropositive conversions. Such positive conversions are frequently of fairly short duration and may not persist for more than three or four weeks. These seropositive episodes are sometimes, but not always, associated with periods of stress such as farrowing.

The appearance of the first seropositive titers in the “normal” infected conventional herds are also frequently associated with periods of stress such as moving of animals to new pens or into new groupings. The onset of estrus may also trigger the development of the initial seropositive conversions. It is currently believed that groups of pigs that reach six months of age with the entire group seronegative for *Mycoplasma hyopneumoniae* probably represent groups that are free of the infection.

At the present time there are no known cross reactions between *Mycoplasma hyopneumoniae* and other swine mycoplasma or plant substances. One possible exception to this may be the recently described swine mycoplasma recovered from the respiratory tract of pigs in Denmark and named *Mycoplasma floccular*. It was initially reported that there may be some cross reactions. This point needs to be clarified and a survey made to determine if *Mycoplasma floccular* occurs in swine in this country.

The identification of *Mycoplasma hyopneumonia* once it is isolated in pure culture has posed many problems in the past. The recent development of techniques to identify colonies with specific monotypic antiserum tagged with either flourescein, peroxidase or latex particles has changed this and resulted in rapid specific identification.

The incidence of lesion free, seronegative, mature animals in infected herds that remain asymptomatic carriers of the organism is not well established. The results of farrowing forty such sows in individual isolated units with subsequent evaluation of their litters at eight weeks of age, indicates that a fairly high percentage of such sows do not infect their litters.

Research is underway to attempt to develop and evaluate practical production facilities that will allow the selection of such seronegative mature sows, farrowing them in isolated units and rearing their litters as isolated units from birth to market weight. Such litters that are free of clinical signs of the disease and have all individuals test negative at market weight are probably free of the disease. Such litters will be evaluated as *Mycoplasma hyopneumoniae*
free breeding stock for founding herds free of this disease. It is still
too early to evaluate the reliability of this program as a practical
measure.

The availability of an effective chemotherapeutic compound to
clear this organism from the respiratory tract of swine would greatly
improve the chances of success with such a control program. There
are several candidate compounds that are undergoing or have under-
gone evaluation by different pharmaceutical companies. It is hoped
that effective compounds may become available in the not too distant
future. When such is the case, then a combination of specialized
management procedures, serologic testing and chemotherapy may
give a practical program for eradication of this disease from seed-
stock and production herds.

The application of the microtiter C.F. serologic test to clinically
affected breeding herds with subsequent removal of reactors from
the breeding herd has usually failed to completely eliminate the in-
festation from the herd. However, almost all such herds have had a
dramatic reduction in the clinical signs of the disease in the subse-
quent farrowing of pigs. Most of the producers who have applied
this procedure have been impressed with the improvement in the
health of their herds.

Recent immunization trials in pigs using Mycoplasma hyopneu-
moniae antigens combined with good adjuvants have indicated that
some protection is afforded against subsequent challenge. This is
evidenced both by the number of pigs that remain free of gross
lesions and by the reduced extent of the lesions in the immunized
pigs that do develop gross lesions. Never-the-less, this organism is a
weak antigen and much research remains before an immunization
product with an acceptable efficiency can be produced. Even after
such a product is available it may be very difficult to produce it at
an acceptable cost.

The only mode of transmission of this disease that is currently
known is aerosol transmission between infected and susceptible
swine over fairly short distances. The causative organism is be-
lieved to be quite short-lived in the environment. However, ex-
perience with the appearance of this disease in surgically derived
herds and conventional herds believed to be free of the infection
indicates that either the infectious aerosols can travel relatively long
distances, that is up to a quarter of a mile, under some conditions
or that other factors are involved in its transmission.

Recent attempts to demonstrate transmission of the infection by
lungworms have been negative.
REFERENCES


Chairman: E. A. Butler, Des Moines, IA
Co-Chairman: T. F. Zweigart, Raleigh, NC

Reports were presented by the sub-committees on TGE and pseudo-rabies.

Dr. Robert Glock reported on the current status of research on the etiology, diagnosis, control and treatment of swine dysentery as well as the increased incidence and increased losses from the disease. Those losses were estimated to be 34 million dollars in 1973 and 64 million in 1974. Losses seem to be increasing each year.

Dr. J. E. Fox reported on the new test requirements being imposed by the Bureau of Foods on diamatrydazole. He indicated that these new tests could delay legal use of that class of drugs for at least 2 years.

The Committee again urges the Bureau of Foods to make all possible haste in the clearance of these drugs for treatment of swine dysentery.

Dr. Wm. Switzer reported on the status of a bacterin being developed for protection against Rhinitis caused by a Bordatella organism. This bacterin looks very promising when used in baby pigs. Two injections are required the first being at 1 week of age and the second at 4 weeks. He expects the bacterin to be useful for use in sows prior to farrowing to protect the baby pigs until immunity would develop from the pig injections.

The Committee reviewed the short term control program proposed by the Iowa Pork Producers and suggests it as a guideline for control programs in other states until such a time that a national eradication program can be implemented.

The plan is as follows:
I. Regulatory
   A. Quarantine to the premise or to slaughter all swine with pseudorabies antibodies.
   B. Quarantine to be released by negative herd test.
   C. Require a negative S. N. test on all imported breeding swine and accept no swine from a herd in which there has been clinical evidence of the disease within 12 months.
   D. All feeder pigs sold should be quarantined to slaughter with provision for movement of animals in case of hardship circumstances.
REPORT OF THE SUBCOMMITTEE ON TRANSMISSIBLE GASTROENTERITIS

Chairman: E. O. Haelterman, Lafayette, IN
E. A. Bohl, L. J. Kemeny

Among the more persistent and expensive problems of the swine industry are infectious diarrheal diseases of young pigs. Two viruses are now associated with such disease. Transmissible gastroenteritis virus is well recognized as causing highly fatal disease of newborn pigs. The second is a rotavirus. Several terms have been used, but it appears most likely that the name rotavirus will be accepted for this agent. It belongs to a group which has been called "reovirus-like agents" "duoviruses" or "orbiviruses" and have been etiologically incriminated in diarrheal disease of calves, foals, lambs and human infants. It is important that the existence of rotaviruses be recognized by diagnosticians and others working with swine enteric diseases.

Limited studies suggest that swine rotovirus is widely distributed in the USA. In herds where it has been identified, diarrheal disease has affected mainly pigs aged one to three weeks. Sows and growing swine are rarely if ever involved. Vomition may occur but is infrequent compared to TGE, and diarrhea persists from 1 to a few days. Death losses are much lower than in typical outbreaks of TGE in which newborn pigs are involved. It may, however, resemble enzootic TGE that occurs in some herds in which continuous farrowing is practiced.

Rotaviruses of pigs (and other species except calves) have proven difficult to adapt to cell cultures. Diagnosis is based mainly on electron microscopy and immune electron microscopy of negatively stained preparations of fecal and intestinal fluid samples. Direct and indirect immunofluorescence techniques have also been developed.

Limited studies on the pathogenesis of rotaviral diarrhea indicate that the virus replicates in enterocytes of the small intestine resulting in their sloughing and the consequent shortening of intestinal villi. The process appears to be similar, but generally less severe, than that occurring in TGE. It is possible that much of disease in rotavirus-infected herds is mitigated by maternal antibody, because of persistence of the virus in herds.

Although TGE has been studied for many years it continues to be a major cause of death losses. The problems center mainly about development of immunizing procedures and controlling spread of the virus.
Attempts to protect neonatal pigs by active immunization or interfering viral infections have failed and emphasis has been on stimulating immunity in sows to be transmitted to their pigs via colostrum and milk. Currently one attenuated parenterally administered vaccine is licensed. Parenteral injection of live or inactivated virus is followed by high titers of antibody in colostrum. It appears, however, that the intestine must be stimulated in order to cause production of the levels of IGA in milk required to provide optimal lactogenic immunity through the lactation period. The problem thus becomes one of how to stimulate adequately the small intestine without resorting to the use of virulent virus.

The persistence and excretion of TGE virus in swine and infection of species other than swine are important points in developing sanitary control and practical management of infected herds. During the acute stages, virus may be shed from the respiratory tract and milk of infected sows as well as through the feces. Although there are reports of TGE virus persisting in the lungs or intestines for up to 3 months, most experimental work and observations of natural outbreaks would indicate that the virus is rarely if ever shed for more than 2-3 weeks after infection. These questions concerning the carrier state in swine are, however, far from being resolved at this time.

Recent work has corroborated earlier reports that canidae may be infected with TGE virus and shed it for up to two weeks, although they do not sicken. Dogs could serve as vectors between herds. TGE virus has produced diarrhea in puppies after a number of serial passages but this appears not to occur naturally. A question remains as to whether TGE virus spreads naturally between dogs. Dogs that have not had contact with swine have had antibody to TGE but this could have been due to cross reaction with a recently described coronavirus of dogs.

Studies with starlings have shown that TGE virus may survive in their bodies for some hours after experimental inoculation, but they do not become infected. Many swine raisers believe that these birds do spread TGE and their role in the epidemiology of TGE should be defined.
REPORT OF THE SUBCOMMITTEE ON
AUJESZKY'S DISEASE (PSEUDORABIES)

Chairman: John P. Kluge, Ames, IA

The subcommittee held an open meeting on November 9, 1976. Position papers prepared by Dr. A. Leman et al., APHIS2, and the Executive Board of the Iowa Pork Producers were circulated3. Mr. S. Beckley presented recommendations of the Board of Directors, National Pork Producers Council4.

Dr. H. Hill reported that the A.A.V.L.D. had established a committee for standardization of pseudorabies diagnostic techniques. The committee will also evaluate new techniques such as the intradermal skin test and an enzyme-labeled assay. Discussion included availability of laboratory facilities for serum neutralization tests (SN), cost/test, and sources of financial support for testing. Mr. Beckley reported the results of a recent survey of laboratories currently involved in pseudorabies SN testing5. Cost estimates ranged from $2.50-$10.00 a test depending on the number of samples. It was estimated that at the present time 2000 sera could be tested per week. Presently there appears to be adequate laboratory capability if financial support were available.

A motion by Dr. R. Glock in support of the A.A.V.L.D. Committee for Standardization of Diagnostic Tests was passed.

Dr. C. J. Maré stated he believed the disease was still relatively rare in the U.S.A., that there was still time to eradicate the disease, and that he felt the use of vaccines would complicate the problem. Dr. Maré made the following motion for presentation to the Transmissible Diseases of Swine Committee (U.S.A.H.A.) . . .

The Committee:
1. Opposes the use in this country of pseudorabies vaccine (whether it be live-virus or inactivated virus vaccine).
2. Recommends that states impose appropriate quarantines on active and confirmed pseudorabies outbreaks to protect other swine producers.
3. Strongly supports the concept of pseudorabies eradication and urges the U.S.D.A., Veterinary Services to proceed immediately with a campaign to eradicate the disease.

Discussion followed on each point of the motion. Dr. Bass reported on a modified-live-virus vaccine, prepared from the Bucharest strain, Norden Laboratories has asked APHIS for permission to conduct field trials with this vaccine. The advantages and disadvantages of limited use of vaccines, their use in endemic areas, and the intrastate and interstate control of vaccines were discussed. Dr. Maré's motion was passed with one negative vote.
FLU — 1976

Richard L. Parker, DVM, MPH

To clarify some of the misunderstandings that have been generated by the National Influenza Immunization Program, I will explain the basis for the decision that was made and the ground rules for the Program. The paper on influenza presented yesterday gave some technical insight into the problems of classification of the organism that causes influenza, not only in humans but also in certain animal species. My remarks are restricted primarily to the human aspects of the disease, and the rationale for the program that has been promulgated at the Federal level and which is currently being implemented by all of the States in the country.

Approximately every ten years there appears to be a major change in the genetic composition of the Type-A influenza viruses that infect man. These major shifts are of sufficient magnitude that the "new" virus is changed enough from the previously prevalent strains of Type-A influenza virus that it is then, in essence, reaching immunologically virgin populations of human beings. Within the ten-year time periods when there are major shifts, there are lesser changes in the antigenic composition of the viruses which have been termed "drifts." There were major outbreaks of influenza in 1946-47, again in 1956-57, 1968 and on the basis of the ten-year cycle, 1976-77 is a reasonably appropriate time period to expect another antigenic shift. Within the ten-year periods, the minor drifts produce a series of smaller outbreaks of influenza. The last major outbreak, of course, was the Hong Kong virus in 1968 and the antigenic composition of the viruses that have appeared since that time are fairly close to the Hong Kong virus, however there are persons in the population with low or no antibody titers against them. Perhaps an example of this would be the outbreak of A/Victoria which occurred in the United States last winter and which involved a fair number of people. There have been estimates that there were excess deaths associated with that outbreak ranging from 7 to 12,000 in this country alone. This virus, of course, has continued to appear throughout the world causing a minor pandemic of influenza.

In February of 1976 an outbreak of A/Victoria occurred at Fort Dix, New Jersey, and an alert medical officer recognized a slightly different clinical syndrome in certain of the troops. He did not actually anticipate that the change he was seeing was due to an influenza virus; he felt it was more likely to be due to an adenovirus. Nevertheless, specimens were collected and submitted to the New

Chief, Bureau of Epidemiology, South Carolina Department of Health and Environmental Control, Columbia, South Carolina.
Jersey State Health Department laboratory where the virus identified was found to be considerably different than any influenza virus isolated there in recent years. The virus was referred to a WHO Reference Laboratory, in this case at CDC in Atlanta. The virus isolated from the troops at Fort Dix very closely resembled the influenza virus which has been frequently isolated from swine in this country. Serologic studies indicated the virus had spread to several hundred soldiers with only a small number having clinical disease.

At that time, unfortunately, the press opted to dub the virus “A/Swine” or simply “Swine Influenza Virus” which is technically a misnomer. Influenza viruses are identified first by their type, then by the locale from which they are isolated (in this case New Jersey), and lastly by a numerical designation relating to the year of isolation. The virus that was isolated is properly referred to as A/New Jersey/76.

There was a careful review of the potentials for an epidemic: the set of circumstances of the major shift, the approximately ten years since the last shift, and the definite evidence that this particular virus was spreading from person to person. On that basis, a decision was made to approach the President of the United States and the Congress to develop a human vaccination program in anticipation of an outbreak in the coming winter season. In March the Congress passed, and the President signed, legislation which provided $135 million for the National Influenza Immunization Program. There were several potential types of programs considered. A program was first considered to provide only vaccine from a totally federally funded program. As the program was finally conceptualized, federal provision of the vaccine was made, some money was allotted to the States for administration and some money was set aside for development of the program and for evaluating the effectiveness of the campaign. Included in the decision-making process was an assessment of cost-benefit ratios without trying to estimate the cost for the potential human illness and loss of life. The estimated cost was nearly one quarter billion dollars to develop a program for providing and administering the vaccine to the major portion of the human population of this country. Retrospective assessments were made of the relative cost, in terms of 1968 dollars, of the outbreaks that had occurred in that year and the 1918 pandemic, which was perhaps the most serious that has ever been recorded. On the basis of these projections, it was felt that a moderate outbreak with a new type of virus would cost billions of dollars. A moderate estimate of 2.5 billion dollars was made as a projection against which one could measure the anticipated cost of a quarter billion. On that basis, a potential 10-to-1 cost-benefit ratio, the decision was made to try to produce enough vaccine.

Field trials were launched in more than 5,000 individuals in the United States to assess the efficiency of the vaccines in producing
antibody response, to test the safety in terms of side reactions, and to establish the appropriate dose that would elicit the desired antibody response while maintaining an acceptably low level of side reactions. Four manufacturers of the vaccine supplied vaccine for those field trials. The vaccine was manufactured by technically different means by each of two groups of the manufacturers. The field trials were reported in June, and at that time it was felt that there was adequate evidence to establish the correct dose for the adult population and to make recommendations as to which types of vaccines should be used in which groups of the population. It was further recognized that there were unresolved problems in recommending dosage and type of vaccine for younger people. Following the field trials and the development of definite recommendations, negotiations were started with the various companies for the production of adequate supplies of the vaccine to achieve the goals that had been set forth in March.

The newspapers and other media have carried endless accounts of the problems that evolved following the March decision to "go ahead." One problem occurred when a technician inadvertently removed the wrong seed stock virus from the freezer which resulted in the production of an incorrect batch of the vaccine. The vaccine producing companies became concerned because of an adverse court ruling on a totally different type of vaccine, which involved millions of dollars, regarding the financial and legal aspects of undertaking a program of the magnitude of the flu program—the largest public health measure that has ever been attempted in any country at any time in the history of man. The resulting debates between insurers, producers and the federal government again made unfortunate headlines, because of the manner in which the press chose to treat the issue without discussing the underlying causes for the concern. The final legislation that was passed in August was apparently drafted hastily, and unfortunately has some serious shortcomings, not the least of which is an absolute prohibition against a profit for the producers of the major portions of the vaccine. The legislation requires that a person receiving the vaccine through public facilities must sign a consent form indicating that he was advised of the potential benefits and risks of receiving such a vaccination. In return for having signed such a document, the government legislation would provide protection not only to the producers of the vaccine, but to all those associated with its administration. Suits launched against either the manufacturer of the vaccine or those administering it would first be fielded by federal attorneys, and only if there was a judgment of actual negligence on the part of the producer or the person administering the vaccine would there be any attempt to recover from those individuals. This again caused some concern when it became known that as a part of this provision any physician ad-
ministering vaccine in his office would not be accorded this protection if he made any charge whatsoever for administering the vaccine, for overhead, for nurses’ services or even for the needle and syringe with which the vaccine might be administered. In most states normal malpractice insurance would cover physicians, as it has in past years during the administration of influenza vaccine, but I think it is quite realistic to recognize that the publicity associated with the vaccine this year has raised a concern on the part of physicians that the public may be more suit-conscious than in previous years.

There are three types of influenza vaccine available in the United States at this time. At the time the decision was made to produce an A/New Jersey vaccine and to provide it to as many people as might wish to avail themselves of it, vaccine manufacturers had already begun production of the A/Victoria strain, which was prevalent last year; vaccine production of the A/Victoria strain was stopped when the decision was made to produce A/New Jersey. Concurrently with the production of the A/Victoria vaccine, there had been production of a Type-B vaccine designated B/Hong Kong/72 which was also terminated when the emphasis was placed on A/New Jersey. An odd situation developed. The Federal government pre-empted all of the Type-A vaccine to be produced in the United States this year, both A/New Jersey and A/Victoria. The A/New Jersey is being combined with the A/Victoria to produce a bivalent vaccine which theoretically is to be administered to people at high medical risk—risk of developing serious complications should they be infected with influenza. (Risk in this sense is generally defined as those over 65 and those of any age with serious heart, lung, metabolic or related disease problems. People who have had an experience with a heart attack, people with chronic bronchitis, people with diabetes, even those with sickle cell anemia are considered to be at unusual risk of the complications of influenza infection.) This left the B/Hong Kong strain of virus available for vaccine production, but it was not being purchased by the government; therefore, it has been marketed by the individual vaccine producers. All this has resulted in a good bit of confusion as to what vaccines are available when, where and for what uses. In summary, Type-B vaccines, which ordinarily protect against influenza outbreaks of limited scope, are available to some degree commercially, and unfortunately have been referred to by some as “regular flu vaccinations.” The Type-A/New Jersey and Type-A/Victoria bivalent vaccine has been made available by the Federal government for the high risk group. The Type-A/New Jersey monovalent vaccine is generally available throughout the United States for anybody who wishes to receive it on a voluntary basis. The Department of Defense has opted to administer a double dose of vaccine to active duty military personnel and to a large degree, Reserve and National Guard troops throughout the United States.
At this time, very definite recommendations have been made for the civilian population, not only as to the type of vaccine, but also the type of production of vaccine for various age groups. The following table summarizes the current recommendations:

<table>
<thead>
<tr>
<th>CATEGORY OF RECIPIENT</th>
<th>VACCINE TYPE</th>
<th>VACCINE MANUFACTURER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. High Risk</td>
<td>Bivalent Split</td>
<td>Wyeth Parke-Davis</td>
</tr>
<tr>
<td>Age 3 through 17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 doses required</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. High Risk</td>
<td>Bivalent Whole</td>
<td>Merck Merrill National</td>
</tr>
<tr>
<td>Age 18 through 24*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. High Risk 25 and Over</td>
<td>Bivalent Whole or Split</td>
<td>All Four Manufacturers</td>
</tr>
<tr>
<td>4. General—Age 17</td>
<td>No Recommendations</td>
<td></td>
</tr>
<tr>
<td>and Under</td>
<td>Yet Received</td>
<td></td>
</tr>
<tr>
<td>5. General—Age 18</td>
<td>Monovalent, Whole</td>
<td>Merck Merrill National</td>
</tr>
<tr>
<td>through 24*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. General—Age 25</td>
<td>Monovalent, Whole</td>
<td>All Four Manufacturers</td>
</tr>
<tr>
<td>and Over</td>
<td>or Split</td>
<td></td>
</tr>
</tbody>
</table>

*Initial dose to be given—Additional trials now under way may indicate need for a second dose of vaccine for proper immune response.

Coupled with the vaccination program has been an intensive surveillance program to monitor the appearance of influenza viruses throughout the world. There have been repeated outbreaks of A/Victoria influenza in various parts of the world, and recently there have even been outbreaks in United States associated territories such as the Island of Guam and at Clark Air Force Base in the Philippines. The failure to recognize A/New Jersey virus any place in the United States suggests that we have not yet seen the surfacing of what may become the dominant strain of influenza virus in the United States this year. This further adds to the confusion as to whether or not we really are on the verge of an outbreak of any sort of Type-A influenza.

We are on the verge of the influenza season in the United States; indeed, many large outbreaks have previously established themselves by mid-November. At this time, although we have seen sporadic cases of Type-B influenza here and there, including South Carolina in the last part of September, we have not yet seen the establishment of a dominant A-type influenza virus in the United States or in North America this Fall. That leaves us right back where we started in February, 1976. We have evidence that we had an emergent virus that was significantly different from the previously recognized
viruses circulating in the population. We have evidence that it spread from person to person, and we know that this type of inapparent spread that occurred in several hundred troops at Fort Dix is exactly the sort of seeding that has triggered pandemics in past years. We have active surveillance which has indicated that the A/Victoria has continued to plague southern hemisphere countries of the world during the summer months and is appearing in countries, or in parts of the Oceana that have frequent contact with the United States. Failing to have the established dominance of any Type-A influenza virus any place in the United States or in North America, at this point in time we have to assume that either might reassert itself as the dominant virus.

The program in South Carolina, as in most other States, is going forward. We cannot say when or where, or even if an outbreak will occur, but we can say that if it does occur in an unvaccinated and immunologically virgin population, the likelihood of excess mortality and the likelihood of great losses in wages, productivity and indeed, the mental and physical loss to the individuals who suffer from such an infection, make continuation of an immunization program well worthwhile. I would editorially add that I think nearly every State in the country is disappointed in the response of the general population in availing themselves of vaccine, and I rather suspect this is in some way related to factors related to publicity—both negative publicity associated with the program and the lack of a serious attempt to put in perspective the relatively minor problems of the program considering its size and the potential risks if the program fails to provide protection should an outbreak of A/New Jersey/76 occur.
REPORT OF THE COMMITTEE ON PUBLIC HEALTH AND ENVIRONMENTAL QUALITY

Chairman: Richard L. Parker, Columbia, SC
Co-Chairman: R. H. Singer, Winchester, KY


The committee met at 1:30 P.M., November 10, 1976. Dr. Erskine Morse announced a planned educational meeting on salmonella control in Washington during the early part of November 1977. Nineteen members were present and discussed at length the practical aspects of utilizing animals as sentinels of disease of public health significance. Several specific instances of maintaining sentinel animals for monitoring the effectiveness of infectious agent containment were presented.

Outbreaks of disease in animals that could have had public health importance were discussed and included infectious diseases such as anthrax and non-infectious diseases caused by agricultural chemicals, pollution associated with mining operations and intoxications resulting from accidental feeding of heavy meals and other chemicals to food producing animals.

Approaches to dealing with the problem discussed included quarantine, indemnification, various surveillance systems and cross reporting of incidents. The discussion clearly indicated a breadth and complexity of the problem that precluded its resolution during the committee meeting.

A resolution was made, seconded and passed to establish a subcommittee to advance at next year’s U.S.A.H.A. meeting a resolution advocating passage of quarantine measures for animals having any condition of public health significance with such powers residing in the authority of the state now having quarantine authority over animal diseases.

This resolution should also advocate requirement that diagnostic laboratories be required to report any animal condition having public health significance to state quarantine authorities and to state public health authorities for appropriate action to prevent human illness from developing.
The Sub-Committee will be composed of:

Dr. Robert Singer—Chairman
Dr. W. C. Burnett
Dr. James Pearson
Dr. M. J. Twiehaus
Dr. F. James Schoenfeld
Dr. H. M. Trabosh
Mr. Charles Jungmichel

Dr. James Steele indicated a desire to present an overview of *Yersinia* infections as a public health problem at next year's meeting.

Apparent travel complications prevented the planned presentations of two individuals of material of committee interest and resulted in adjournment at an early hour.

This report is respectfully submitted to the Executive Committee for its consideration and acceptance.
AFLATOXIN B₁ INCREASES INFECTIOUS DISEASE LOSSES IN FOOD ANIMALS
G. T. Edds, DVM, PhD and O. Osuna, DVM, MS

Improvements in animal productivity is based on the control and eradication of disease, improved nutrition and better breeds of livestock. Thus, two important factors in this triangle are related to quality of the ration being consumed by food animals as this may influence production of quality meat, milk and eggs. Losses from disease in livestock resulting from wasted labor and nutritionally inadequate rations are immense. For instance, the mycotoxins have been detected at levels in feed in the Southeastern U.S. that result in liver damage and stunting in both swine and poultry. Both in the developed and developing countries these two species afford the quickest way to provide proteins needed for human requirements.

The term aflatoxin was assigned to the toxic materials associated with certain strains of the mold A. flavus before its complex nature was determined. Mycotoxicosis was defined as poisoning of a host after entrance into the body of toxins of fungal origin. The aflatoxins B₁ and B₂ produced blue fluorescence on thin-layer chromatography plates and G₁ and G₂ produced greenish fluorescence.

During the last decade, scientific discoveries and continuing commercial agricultural interests have emphasized the hazards of aflatoxins in animal and poultry production as well as to mankind. Peanuts, pecans, cassava, bread, cheese, cream, and butter, and rice, corn, sorghum, and other grains are susceptible to invasion by toxigenic strains of A. flavus.

Table I

Aflatoxin B₁, Guidelines for Animal Feeds

Canada—“Acceptable”
France—700 ppb. basic ingredient; 50 ppb. finished feed
Germany, West—200 ppb.
Britain—50 ppb.
Common Market Nations—150 ppb.
Sweden—600 ppb.
South Africa—800-1200 ppb.
Poland—0 level for calves to 3 months, piglets, laying hens, breeding hens, broilers, and meat turkeys
—4 to 99 ppb. cattle and sheep feeds

Factors Influencing Aflatoxicosis

1. Species of Animal
2. Age—Young animals very susceptible

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3. Sex—Males more susceptible than females
4. Parasitic diseases with liver damage; flukes, ascarids.
5. Large, single dose, 0.5-1.0 mg/kg vs chronic, 500 ppb. in feed
6. Adequate nutrition; 18% protein levels better than 14%—swine
7. Vitamin K addition to protect against decreased prothrombin
8. Bile deficiency, obstructive jaundice with poor Vitamin K absorption, Vitamin A absorption, storage and utilization

Previous reports have provided data on the acute and chronic effects of aflatoxins in animals, including poultry (Table II).

An extensive episode of toxicologic disease in dogs was reported in 1952, the problem was later associated with a commercial dog food in which contaminated peanut meal was the principal protein source. This condition was similar to moldy corn poisoning in swine. Research associated with extensive losses in turkeys in England in 1960 from consumption of feed in which Brazilian groundnuts (peanuts) were a source of protein led to the isolation and characterization of the aflatoxins. These agents cause severe hepatotoxicosis in many species of animals and carcinogenesis in others. In fish, birds, and mammals, the high carcinogenicity associated with feeding amounts as low as 15 p.p.b., in comparison with other hepatic carcinogens, would indicate the aflatoxins, as exemplified by aflatoxin B1, are the most potent carcinogens so far recognized.

Domestic animal species, such as cattle, swine, turkeys, chickens, and ducks, consuming sublethal amounts of aflatoxins for several days develop a toxic syndrome in which liver damage is the most significant change. Cumulative toxic amounts vary from 0.3 to 15 p.p.m.

Moldy corn toxicoses in swine and cattle were characterized by hemorrhaging in many tissues including liver, esophagus, stomach, intestines, skeletal muscle, and subcutis. The intestines and sometimes the abdominal cavity of pigs were filled with blood. Similar characteristics included frequent icterus; variable amounts of fatty changes in the liver, visible grossly and microscopically, with cirrhosis developing in the more chronic cases; necrosis of hepatic cells, followed by atrophy of affected lobes; considerable bile duct proliferation; and hemorrhages in several organs, tissues, and cavities immediately preceding death.

Species of A. flavus grow at temperatures above 70 F. (21.1 C.) and at a moisture content of 10 to 40%. Drying techniques that reduce the moisture content of shelled peanuts or grains to less than 14% reduce the storage problem.

Samples of corn from commercial markets, previously shown to contain aflatoxin, were examined to determine the distribution of toxin within the bulk of the corn. A greenish-gold fluorescence under ultraviolet light (365 nm.) was associated with the presence of
aflatoxin. Damaged kernels with the characteristic fluorescence contained as high as 88,500 to 101,000 p.p.b. aflatoxin B₁, indicating that the toxin contamination could be concentrated within a few kernels in a corn sample. In two of thirteen contaminated samples examined, aflatoxin B₁ was found in high concentrations in the broken corn-foreign material, accounting for most of the toxin in the total sample.

Investigation of toxin occurrence in ears of field corn grown at geographically diverse locations demonstrated that corn from areas in the southern United States had significantly higher levels of toxin than did similar samples from the Midwest. Other studies supported the premise that growing conditions in the South were more conducive to A. *flavus* infection of corn and subsequent synthesis of toxin. A definitive examination of the field occurrence of *A. flavus* and aflatoxin was made in 1973 with corn from a region of South Carolina. Of the test samples, 60 percent contained kernels internally colonized by the fungus and 32 percent were contaminated with the toxin at levels exceeding 20 parts per billion, the action guideline of the Food and Drug Administration.

In addition to species and breed variations in susceptibility to aflatoxins, nutritional and disease factors influence the degree of response to these toxins. Striking differences in susceptibility to aflatoxin were observed in 17 different breeds and strains of poultry and game birds, 2 to 6 weeks of age, fed a ration containing 800 p.p.b. aflatoxin B₁. A diet low in lipotropic factors predisposed to greater hepatotoxicity in rats. Cockerels fed a semipurified diet at 4 protein concentrations, and containing aflatoxin, had more serious lesions at the lowest protein concentration. Both 4- and 10-week-old pigs, when fed rations containing high amounts of protein (20.6 to 17.0%) vs low concentrations (14.1 to 11.4%), developed more serious signs and lesions at the lower concentrations. These signs and lesions included stunting, icterus, with hepatic cell necrosis, hemorrhage, and bile duct hyperplasia, along with hydropic and fatty degeneration of hepatocytes.

Aflatoxin (B₁ activity of 0.25 to 0.5 p.p.m.) has been shown to interfere with the development or the manifestation of acquired resistance in 20 to 67% of the turkey pouls and chicks that have eaten it during or after the period of immunization against *Pasteurella multocida*. When aflatoxin was fed for 3 weeks, it caused reduced rate of body weight gain and microscopic changes in the liver. Feeding an aflatoxin-free ration for the next 3 weeks resulted in a return to normal growth rate and liver functions. However, the immunologic defect remained in the principals that were vaccinated during the period of aflatoxin consumption.

Experiments were performed here to observe the sequence of changes produced by aflatoxin B₁ in New Hampshire chicks to de-
termine its possible interference with the protection afforded by a coccidiostat against cecal coccidiosis or the resistance developing therefrom.

The coccidiostat afforded a high degree of protection against cecal coccidiosis in the treated groups of chicks (groups 5 through 8); only 1 chick died 5 days after exposure in the B1-exposed vaccinated group (group 8). In contrast, in the 4 nontreated groups of chicks (groups 9 through 12), 20 chicks died within 6 days in the B-exposed nonvaccinated and vaccinated groups (groups 10 and 12), and 10 died in the nonvaccinated and vaccinated groups (groups 9 and 11) given normal feed (Fig. 1).

Studies have been done on the comparative response of New Hampshire or commercial broiler chicks fed aflatoxin B1-contaminated feed for 28 days, allowed a 21-day recovery period (fed standard starter feed), and then infected with cecal coccidiosis. Results in preliminary experiments had shown that aflatoxin B1 concentration of 2 ppm in starter feed was required in broiler chicks to produce toxicosis and lesions comparable with those seen in New Hampshire chicks exposed to feed containing 0.2 ppm.

In these experiments, although there was apparent recovery from aflatoxicosis in both New Hampshire and broiler chicks (on the basis of physical appearance and weight gains), aflatoxin-fed and non-coccidiostat-treated chicks were more susceptible and had more severe hepatic and cecal lesions when challenge exposed to *E. tenella* oocysts, even at 49 days of age. Lack of deaths in the older chicks may have resulted from the relatively lower infective dosage of coccidial oocysts per kilogram of body weight. These results support the earlier conclusion that factor(s) associated with the broiler's resistance had been lowered by exposure to aflatoxin B1. This increased susceptibility to cecal coccidiosis persisted, even though the chicks had regained normal appearance and weight gains. The interference with normal hepatic function probably reduced synthesis of serum-immune globulins, which adversely influenced pathogenesis and morbidity rate.

Siller and Ostler isolated *Salmonella* from the internal organs of turkeys with aflatoxicosis. Brown and Abrams consistently isolated *Salmonella* from both chickens and ducklings receiving dietary aflatoxin. Subsequent studies showed that dietary aflatoxin increased the susceptibility of chickens to fowl typhoid, paratyphoid infections, and *Candida albicans* infection. The interaction of a mycotoxin with other diseases is not limited solely to aflatoxin since T-2 toxin can also interact with *Salmonella* infections (1).

An experiment, "Toxic Effects of Aflatoxin B1 In Male Holstein Calves with Prior Infection by Flukes" was designed to compare three single dose levels of aflatoxin B1 (0.0, 0.5, and 1.0 mg/kg of body weight) and two levels of flukes (0 and 220) to determine
whether an additive effect from aflatoxin B₁ occurs when fascioliasis is present in dairy calves. Twenty-four male, Holstein calves, four weeks old, and averaging 101 pounds, were assigned at random to six treatment groups, four calves per group: Group 1—negative control; Group 2—0.5 mg/kg B₁; Group 3—1.0 mg/kg B₁; Group 4—220 flukes; Group 5—220 flukes plus 0.5 mg/kg B₁; and Group 6—220 flukes plus 1.0 mg/kg B₁.

Each calf in groups 4-6 received a single oral dose of 220 fluke metacercariae at the beginning of the ten week experiment. Five weeks later, each calf in groups 2, 3, 5, and 6 received a single oral dose of aflatoxin B₁.

Results in the principals included a significant decrease of dry matter intake (P < 0.006), body weight (P < 0.024), and serum albumin (P < 0.04), and, in groups infected with 220 flukes, significantly increased values of prothrombin time (P < 0.007). Significant differences in the number of flukes recovered from the livers were seen in the groups receiving 0.5 and 1.0 mg/kg (P < 0.007). Significant differences in the number of flukes recovered from the livers were seen in the groups receiving 0.5 and 1.0 mg/kg (P < 0.046) of aflatoxin.

A single oral dose of 220 fluke metacercariae resulted in significantly increased levels of serum total protein (P < 0.003) and globulins (P < 0.01). Observations on the development of the flukes from metacercariae to the mature state with descriptions of sizes, numbers, feeding habits, and pathologic lesions were included.

The differences in the numbers of flukes recovered from the livers between the fluke-infected groups 4-6 and presence of pneumonia in calves of group 6 suggested that aflatoxin B₁ produced persisting lowered resistance. In all animals necropsied, the liver was the organ most affected with aflatoxin B₁, as well as with flukes. Periportal fibrosis, monocytic infiltration, fatty filtration, and bile duct proliferation were the characteristic lesions induced by aflatoxin B₁. In conclusion, additive toxic effects were observed in the groups dosed with flukes and aflatoxin B₁ with significant variations of serum and plasma values as well as severity of histopathologic lesions. See Table III.

Aflatoxicosis Results in Increased Susceptibility
1. Turkeys—Candidiasis
   —Pasteurella infections
   —Salmonella infections
2. New Hampshire Chicks
   —Coccidiosis—E. tenella
   —Marek's disease
3. Male Holstein Calves
   —Flukes—F. hepatica
   —Clostridial infections—C. novyi; C. perfringens
4. Aflatoxicosis represents one of the most serious diseases of poultry, livestock, other animals and mankind.
### Table II

**Aflatoxicosis in Animals - Veterinary Science**

1967 - 1975

<table>
<thead>
<tr>
<th>Species</th>
<th>Stunting</th>
<th>BDP</th>
<th>VAC</th>
<th>Icterus</th>
<th>Depression</th>
<th>Death</th>
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<td>++</td>
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<td>+</td>
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<td>++</td>
<td>++</td>
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<td>+</td>
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<td>-</td>
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<td>++</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

(Rough hair-coats, arched backs, severe straining, edema, and hemorrhage)

**BDP** - Bile Duct Proliferation

**VAC** - Parenchymal Cell Vacuolation
### Table III. Gross Liver Lesions Observed at Necropsy

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<tr>
<th>Calf No.</th>
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<th>Nodular Surface</th>
<th>Ecchymotic Hemorrhage</th>
<th>Fluke NOS.</th>
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<td>-</td>
<td>***</td>
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<td>*</td>
<td>-</td>
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</tr>
<tr>
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<td>**</td>
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<td>-</td>
<td>11</td>
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<td>*</td>
<td>-</td>
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<td>17</td>
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<td>17</td>
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<td>-</td>
<td>-</td>
<td>(Avg,13)</td>
</tr>
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<td>*</td>
<td>-</td>
<td>**</td>
<td>46</td>
</tr>
<tr>
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<td>**</td>
<td>-</td>
<td>-</td>
<td>39</td>
</tr>
<tr>
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<td>*</td>
<td>-</td>
<td>-</td>
<td>15</td>
</tr>
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<td>21</td>
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<td>***</td>
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<td>24</td>
<td>****</td>
<td>****</td>
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</table>

- = normal

* - **** = mild to severe
GROUP NO.  

<table>
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<th>TREATMENT</th>
</tr>
</thead>
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<tr>
<td>5   Nonvaccinated, exposed to <em>E. tenella</em>, given coccidiostat</td>
</tr>
<tr>
<td>6   Nonvaccinated, fed B, exposed to <em>E. tenella</em>, given coccidiostat</td>
</tr>
<tr>
<td>7   Vaccinated, exposed to <em>E. tenella</em>, given coccidiostat</td>
</tr>
<tr>
<td>8   Vaccinated, fed B, exposed to <em>E. tenella</em>, given coccidiostat</td>
</tr>
<tr>
<td>9   Nonvaccinated, exposed to <em>E. tenella</em></td>
</tr>
<tr>
<td>10  Nonvaccinated, fed B, exposed to <em>E. tenella</em></td>
</tr>
<tr>
<td>11  Vaccinated, exposed to <em>E. tenella</em></td>
</tr>
<tr>
<td>12  Vaccinated, fed B, exposed to <em>E. tenella</em></td>
</tr>
</tbody>
</table>

Figure 1
AFLATOXIN RESIDUE IN EDIBLE TISSUES OF FOOD-PRODUCING ANIMALS RESULTING FROM FEED CONTAMINATION
Joseph V. Rodrigs, DVM and Leonard Stoloff, DVM

Even before the chemistry of the aflatoxins had been fully known, Allcroft and Carraghan (1963) postulated that the residues of these compounds might be present in the meat, milk, and eggs of animals receiving aflatoxin-contaminated feeds. That this postulate is correct was demonstrated, in part, by these same investigators and in full by the more than 30 studies and surveys which have followed their pioneering work. The subject was reviewed exhaustively in 1972 (Purchase, 1972) but a good deal more information has developed since that time and is reviewed here together with the earlier work.

Only cursory reference will be made to the chemistry and toxicology of the various aflatoxins which have been detected in foods of animal origin. Rather, this review will dwell for the most part on two elements of the problem:

1) The experimentally-derived relationships between aflatoxin levels in animal feeds and aflatoxin residue levels in edible tissues.

2) The natural occurrence of aflatoxins in meat, milk, and eggs.

EXPERIMENTAL STUDIES

Parameters Affecting Tissue Residue Patterns

From experience with drugs used in food-producing animals, it is known that the quantitative and, in some cases the qualitative, nature of tissue residues can be affected by a number of parameters, most important of which are:

1) Species and breed of the animals receiving the drug.

2) Level, mode, and duration of exposure to the drug.

3) State of health and diet of the animal, and

4) Time after cessation of drug exposure that tissues are analyzed.

At least in terms of the ratio of aflatoxin levels in feed and levels of aflatoxin in edible tissues of animals receiving contaminated feed (feed/tissue ratio), it appears that aflatoxin is subject to the same set of influences. As will be seen in the data summary given below, the most striking differences appear among species, but significant intraspecies differences appear to occur as well. The latter may be due to breed differences but may also result from differences in mode
of administration of aflatoxin, duration of exposure, or the age, health, and diet of the animals. No study has been conducted to determine which of these parameters is most important or, indeed, to determine if the apparent differences are statistically significant differences.

The tabulation of feed/tissue ratio data which we have undertaken to review, is intended to serve the purpose of regulatory and public health officials seeking to control human exposure to aflatoxin in food of animal origin by placing restrictions on the aflatoxin levels in feeds. Although certain studies may simulate conditions of animal husbandry in some countries more than others and while there may be several other reasons for believing that the results of one or more specific studies are most appropriate for regulatory purposes, we have collected all available data, representing a range of possible field conditions which might obtain anywhere, and have not eliminated any study which approximated a possible field situation.

**Feed/Tissue Ratios**

All studies of the metabolism and disposition of aflatoxin in food-producing animals have been limited by the lack of assay methods capable of detecting metabolites other than aflatoxin M₁. Thus, experimental studies have been restricted to measurements of aflatoxins B₁, B₂, G₁, G₂ and M₁. In most cases the analytical methods used were capable of measuring these compounds at levels of 0.05-0.1 ppb (or ug/liter), although in some of the earlier studies the detection limits were only ca 1-2 ppb.

In Tables I-IV are collected the data which have been generated on aflatoxin feed/tissue ratios. The Tables are organized by animal species and, in order to present the data in a uniform format, all feed concentration data have been expressed as aflatoxin B₁ levels in ug/kg dry feed weight. Although such a treatment of the experimental data may tend to oversimplify studies in which other aflatoxins were present in the feed, in almost all cases the tissue determinations were for B₁ and/or M₁ only, both of which derive from dietary B₁ only. Further, the Tables omit tissue data for aflatoxins other than B₁ and M₁ since, in almost all cases, the other detected aflatoxins were at much lower levels.

Those who wish to make an in-depth study of the subject of aflatoxin residues are urged to consult the original studies from which the data in Tables I-IV were collected since there was considerable variation in experimental design and execution among these studies. Our purpose is to show the range of the most significant feed/tissue ratios expected under a wide variety of possible field situations.

In Table V are summarized the average feed/tissue ratios derived
in the case of dairy cattle by considering each experiment as a single data point and ignoring the number of data points per experiment and are derived for poultry, beef cattle, and swine by using only the data which could be quantitated and those studies that simulate a condition of animal husbandry expected in the United States. Regardless of whether policy-makers choose to consider the average, the minimum, or some other feed/tissue ratio as the most appropriate starting point for devising feed control regulations, the current state of our knowledge of this subject is summarized for their use in Tables I-V. Questions such as the effects of various aflatoxin levels on the health of man and animals and the effects of any proposed tolerances on the food supply obviously have to be considered, but all are outside the scope of this paper.

Experimental studies have shown that aflatoxin M₁ can be excreted in the milk of lactating animals other than dairy cattle including goats, ewes, and man (Purchase, 1972) and aflatoxin B₁ has been measured in the eggs of quails fed rations containing B₁. In the latter case, .025% to 0.5% of the B₁ content of the ration could be detected in the eggs (Mitzlaff et al, 1974).

Natural Occurrence of Aflatoxins in Meat, Milk, and Eggs

The laboratory observations discussed above can be reflected in field situations. Surveillance of meat, milk, and eggs in the marketplace has been limited, but aflatoxin M₁ residues have been detected in commercial milk and milk products. If the experimental feed/tissue ratio data approximate reality, then detectable residues of aflatoxin are likely to be found in meat or eggs only when feed is contaminated at levels considerably higher than those which can give rise to milk contamination.

The available data on the occurrence of aflatoxin M₁ in milk are summarized in Table VI. In light of the information on the levels and incidence of aflatoxin contamination of several important feed ingredients (oilseed meals and grains), the data on the M₁ residues in dairy products is not surprising; indeed, a relatively high incidence of milk contamination probably exists everywhere the aflatoxin problem exists and is no doubt a good indication of the overall extent of contamination of oilseeds and grains.

To our knowledge, only a single survey of commercial eggs for aflatoxin contamination has been carried out. In a joint study by the U.S. Department of Agriculture and the F.D.A., eggs were selected from those areas of the United States where aflatoxin contamination of feed ingredients occurs most frequently and at highest levels. No aflatoxin was detected in any of 75 samples of liquid and dried eggs. The limit of detection of the method of analysis was 0.2 ug B₁/kg whole egg (Stoloff, 1975).
No information has been developed on the natural occurrence of aflatoxin in meat. Assuming the experimental data reflect reality, it is expected that pork is more susceptible to contamination than poultry meat or beef, since the observed feed/tissue ratios appear to be lower for swine than for broilers or beef cattle.

OTHER CONSIDERATIONS

Other Aflatoxin Metabolites

The major shortcoming in the available data on the accumulation of aflatoxins in edible tissues of food producing animals, is the absence of information on metabolites other than M₁. Those metabolites which have been identified in experimental animals are (aflatoxicol, and aflatoxins P, Q, B₂a) have not been investigated in food-producing animals but it is not unlikely that one or more of these compounds accumulate in edible tissues. Since none appears to be more toxic than aflatoxin B₁, their detection in meat, milk or eggs would be significant only if the level at which they occur substantially exceeds the level of B₁ or M₁. Water-soluble conjugates of these or other aflatoxin metabolites are also likely contaminants of edible animal tissues, but such compounds are, perhaps, less likely to be of human health concern than the nonconjugated aflatoxins.

Since some animal feed ingredients are known to be susceptible to aflatoxin contamination, a thorough investigation of the fate of at least aflatoxin B₁ in food-producing animals is an important public health objective. A good supply of radiolabelled B₁ is obviously going to be necessary to accomplish this task efficiently.

Withdrawal Periods

The studies collected and summarized in Tables I-IV varied to some extent in the lengths of time (withdrawal periods) after aflatoxin exposure that animal tissues were examined. However most of the studies rather closely simulated normal conditions of animal husbandry (“normal” can of course vary among countries or regions). It has been demonstrated that the level of aflatoxin residues in meat, milk, and eggs does not increase but indeed falls off with time after exposure, and some of the studies contain extensive data on post-exposure residue depletion. In some cases (i.e., the use of veterinary drugs) withdrawal periods are an integral consideration in establishing the conditions of safe drug use and in devising regulation, but it is not reasonable to expect that aflatoxin-contaminated feed commodities will be used routinely in the same, well-controlled ways that animal drugs are used. It is reasonable to work from the premise that contaminated feed can be present in the animal diet up to the last feeding before slaughter. The post-exposure depletion data might be used to guide feeding in situations where controls exist.
Detoxification of Animal Feeds

Several procedures have been found useful for detoxification of cotton seed meal, peanut meal, and corn and are being reviewed by Goldblatt.

In the United States, the FDA has required that tissue from animals receiving feed that has undergone ammoniation for purposes of detoxification be examined for toxic residues, even though the reduction of aflatoxin levels during ammoniation has been shown to be substantial. This precaution is necessary because of the possible conversion of aflatoxin to other toxic products during ammoniation, or because of the possible reconversion to aflatoxin of the reaction products after ingestion by the animals.

In one such study, ammoniated, aflatoxin-contaminated cottonseed meal was fed to cows. Although no aflatoxins were detected in the milk from these cows, the milk produced significant liver damage and an incidence of liver cancer when fed to rainbow trout known to be highly sensitive to the effects of aflatoxin. In the same study market milk used as a control produced a low incidence of liver tumors; this observation merits considerable additional study (Sinnhuber et al, 1976).

It appears that considerable further investigation on the edible tissues from food-producing animals receiving aflatoxin detoxified feed is necessary before it can be concluded that such products are truly detoxified.

CONCLUSIONS

This review of aflatoxin residues in foods of animal origin is by no means a thorough examination of the subject but rather was intended to emphasize data most useful for regulatory decisions. As more countries enter into some form of aflatoxin regulation, diversion of contaminated commodities from food use to feed use may become more common. Such a practice will be beneficial in that it will increasingly protect man from direct exposure to at least the highest levels of aflatoxins.

But it must be emphasized that this practice should not be undertaken without adequate controls. Diversion of heavily contaminated corn from direct human use, to dairy cattle use could result in wider human exposure to aflatoxins through milk although, the level of exposure will certainly be much lower than the level which those individuals consuming the corn would have received. Additionally, the diversion to dairy cattle would result in increased risk of infant exposure, and the decision to divert contaminated feed from direct human use to animals (especially dairy cattle) should not be made without regard to such consequences.
On the basis of the data presented in Tables I-IV, some animal feed uses (beef cattle, broilers, layers) would allow considerably higher levels of aflatoxin before detectable residues appear in edible products. In simplest terms, contaminated feed for use in dairy cattle ought to be more carefully controlled than other feed uses. Of course, further investigations into the metabolic fate of aflatoxin in food-producing animals may reveal that our present conclusions need modification, but significant surprises are not expected.
### Table 1

<table>
<thead>
<tr>
<th>Breed of Cow(s)</th>
<th>Aflatoxin in Feed</th>
<th>Aflatoxin in Milk</th>
<th>Rf in Feed/Milk</th>
<th>Study</th>
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<td>(µg/kg dry wt.)</td>
<td>(µg/l)</td>
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<td>1.33</td>
<td>496</td>
<td>8</td>
</tr>
</tbody>
</table>

<sup>a</sup> ND = not detectable  
<sup>b</sup> T = trace amount

(Cont. on next page)
AFLATOXIN RESIDUE IN EDIBLE TISSUES

TABLE II

Summaries of available studies in cattle of the relationship between feed levels of aflatoxins and $B_1$ and $M_1$ levels in edible tissues.

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Level in Feed (µg/kg)</th>
<th>Level in Tissue</th>
<th>Ratio - Feed/Tissue</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$A_1$</td>
<td>$B_1$</td>
<td>$M_1$</td>
<td></td>
</tr>
<tr>
<td>Liver</td>
<td>1,250</td>
<td>0.09</td>
<td>0.16</td>
<td>1,390</td>
</tr>
<tr>
<td></td>
<td>1,000</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>&gt;200</td>
</tr>
<tr>
<td>Kidney</td>
<td>1,250</td>
<td>0.23</td>
<td>0.72</td>
<td>5,434</td>
</tr>
<tr>
<td></td>
<td>1,000</td>
<td>1-2</td>
<td>ND</td>
<td>ca. 700</td>
</tr>
<tr>
<td>Muscle</td>
<td>1,250</td>
<td>ND</td>
<td>ND</td>
<td>&gt;12,500</td>
</tr>
<tr>
<td></td>
<td>1,000</td>
<td>1-2</td>
<td>ND</td>
<td>ca. 700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ND</td>
<td>ND</td>
<td>&gt;1,000</td>
</tr>
<tr>
<td>Liver</td>
<td>693</td>
<td>0.05</td>
<td>0.1</td>
<td>13,860</td>
</tr>
<tr>
<td>Kidney</td>
<td>693</td>
<td>ND</td>
<td>0.2</td>
<td>&gt;14,000</td>
</tr>
<tr>
<td>Muscle</td>
<td>693</td>
<td>ND</td>
<td>ND</td>
<td>&gt;14,000</td>
</tr>
</tbody>
</table>

° withdrawal time 26 hours
* withdrawal time 18-24 hrs.
** withdrawal time 72 hours
*** withdrawal time 6-7 hours

Study 1
Polan et al., 1974; Telcon John Hayes

Study 2
Keyl et al., 1970; Keyl and Booth, 1971; Garrett et al., 1968; Masri, 1974; Telcon Masri

Study 3
McKinney et al., 1973; Telcon A. S. Hoversland
TABLE III

Summaries of available studies in swine of the relationship between feed levels of aflatoxins and $B_1$ and $M_1$ levels in edible tissues

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Level in Feed (μg/kg)</th>
<th>Level in Tissue (μg/kg wet wt.)</th>
<th>Ratio - Feed/Tissue</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aflatoxin $B_1$</td>
<td>Aflatoxin $B_1$</td>
<td>Aflatoxin $M_1$</td>
<td>Aflatoxin $M_1$</td>
</tr>
<tr>
<td>Liver</td>
<td>400</td>
<td>av. 1.3 1.4</td>
<td>308 286</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 2.7 2.0</td>
<td>148 200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>av. 0.5 0.6</td>
<td>400 333</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 0.8 1.5</td>
<td>250 133</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>av. 0.2 0.1</td>
<td>500 1000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 0.3 0.2</td>
<td>333 500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>810</td>
<td>&lt;1 ND</td>
<td>&gt;810 &gt;1000</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>417</td>
<td>av. 12 T</td>
<td>35 &gt;400</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 51 3</td>
<td>8 139</td>
<td></td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>av. 10 T</td>
<td>25 &gt;250</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 92 3</td>
<td>3 83</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,760</td>
<td>av. 0.1 0.05</td>
<td>17,600 35,200</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 0.4 0.2</td>
<td>4,440 8,800</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3,986</td>
<td>av. 3 1.5</td>
<td>1,329 2,657</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 6 3</td>
<td>664 1,328</td>
<td></td>
</tr>
<tr>
<td>Kidney</td>
<td>400</td>
<td>av. 1.2 0.1</td>
<td>333 4,000</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 3.3 0.2</td>
<td>121 2,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>av. 0.3 0.1</td>
<td>667 2,000</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>max. 0.5 0.2</td>
<td>400 1,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>av. 0.2 0.06</td>
<td>500 1,667</td>
<td></td>
</tr>
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<td>333 1,000</td>
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<tr>
<td></td>
<td>810</td>
<td>ca. 4 ND</td>
<td>ca. 200 &gt;800</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>417</td>
<td>av. 6 1</td>
<td>70 417</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 50 6</td>
<td>8 70</td>
<td></td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>av. 4 T</td>
<td>63 &gt;250</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>max. 10 3</td>
<td>25 83</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,760</td>
<td>av. 0.2 1.3</td>
<td>8,800 1,353</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 0.7 2.5</td>
<td>2,514 704</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3,986</td>
<td>av. 0.1 0.5</td>
<td>39,860 7,972</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 0.2 1.0</td>
<td>19,930 3,986</td>
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### Table III (continued)

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Level in Feed (µg/kg)</th>
<th>Level in Tissue (µg/kg wet wt.)</th>
<th>Ratio - Feed/Tissue</th>
<th>Study</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Aflatoxin B1</td>
<td>Aflatoxin B1</td>
<td>Aflatoxin B1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>av. 1.0</td>
<td>0.2</td>
<td>400</td>
<td>2,000</td>
</tr>
<tr>
<td>Muscle</td>
<td>max. 2.2</td>
<td>0.4</td>
<td>182</td>
<td>1,000</td>
</tr>
<tr>
<td></td>
<td>av. 0.5</td>
<td>0.07</td>
<td>400</td>
<td>2,857</td>
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<td>0.09</td>
<td>286</td>
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<td>av. 0.2</td>
<td>0.03</td>
<td>500</td>
<td>3,333</td>
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<td>max. 0.2</td>
<td>0.04</td>
<td>500</td>
<td>2,500</td>
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<td>810</td>
<td>ca. 0.5</td>
<td>ND</td>
<td>ca 1,620</td>
</tr>
<tr>
<td></td>
<td>417</td>
<td>av. T</td>
<td>ND</td>
<td>&gt;400</td>
</tr>
<tr>
<td></td>
<td>max. T</td>
<td>ND</td>
<td>&gt;400</td>
<td>&gt;800</td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>av. T</td>
<td>ND</td>
<td>&gt;250</td>
</tr>
<tr>
<td></td>
<td>max. T</td>
<td>ND</td>
<td>&gt;250</td>
<td>&gt;500</td>
</tr>
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<td>3,986</td>
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<tr>
<td></td>
<td>0.1</td>
<td>0.05</td>
<td>39,860</td>
<td>79,720</td>
</tr>
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</table>

**Study 1**

Jacobson et al., 1975; Telcon W. C. Jacobson

**Study 2**

Keyl et al., 1970; Keyl and Booth, 1971; Hintz et al., 1967; Masri ltr., 1974; Telcon S. Masri.

**Study 3**

Krogh et al., 1973

**Study 4**

Jemmali and Murthy, 1974
### TABLE IV

Summaries of available studies in poultry of the relationship between feed levels of aflatoxin and aflatoxin B₁ and M₁ levels in edible tissues

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Type</th>
<th>Level in Feed (ug/kg)</th>
<th>Level in Tissue (ug/kg wet wt.)</th>
<th>Ratio-Feed/Tissue</th>
<th>Study</th>
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<tr>
<td></td>
<td></td>
<td>Aflatoxin <em>B₁</em></td>
<td>Aflatoxin <em>B₁</em></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Aflatoxin <em>M₁</em></td>
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<td></td>
<td></td>
<td></td>
<td>Aflatoxin <em>M₁</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liver</td>
<td>B⁸</td>
<td>1,600</td>
<td>&lt;1</td>
<td>&gt;1,600</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>800</td>
<td>&lt;1</td>
<td>&gt;800</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>400</td>
<td>&lt;1</td>
<td>&gt;400</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B⁷</td>
<td>1,700</td>
<td>&lt;2</td>
<td>&gt;850</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>1,360</td>
<td>&lt;2</td>
<td>&gt;680</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>4,300</td>
<td>&lt;2</td>
<td>&gt;2,150</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>1,170</td>
<td>av. 20</td>
<td>59</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 23</td>
<td></td>
<td>51</td>
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<td></td>
<td></td>
<td>180</td>
<td>207</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L⁵</td>
<td>1,170</td>
<td>av. 70</td>
<td>59</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 22</td>
<td>198</td>
<td>53</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>180</td>
<td>207</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>1,860</td>
<td>&lt;1</td>
<td>&gt;1,860</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>88,000</td>
<td>687 estimated</td>
<td>537</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Total-112,600)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>100</td>
<td>av. 0.12</td>
<td>833</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 0.35</td>
<td></td>
<td>285</td>
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<tr>
<td></td>
<td></td>
<td>500</td>
<td>av. 0.38</td>
<td>1,316</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>max. 1.10</td>
<td></td>
<td>455</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1,000</td>
<td>av. 0.25</td>
<td>4,000</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>max. 3.70</td>
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<td>270</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>2,000</td>
<td>av. 7.90</td>
<td>253</td>
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<tr>
<td></td>
<td></td>
<td>max. 22.10</td>
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<td>90</td>
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</tr>
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<td>5,000</td>
<td>av. 5.95</td>
<td>840</td>
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<tr>
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<td>max. 18.35</td>
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<td>272</td>
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<td></td>
<td></td>
<td>10,000</td>
<td>av. 8.72</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>max. 21.37</td>
<td></td>
<td>468</td>
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<td></td>
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<td>15,000</td>
<td>av. 15.45</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>max. 21.10</td>
<td></td>
<td>711</td>
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</tr>
</tbody>
</table>

⁸B = broiler

⁵L = layer

(Continued on next page)
### Table IV (continued)

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Type</th>
<th>Level in Bird (µg/kg)</th>
<th>Level in Tissue (µg/kg wet wt.)</th>
<th>Ratio - Feed/Tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Aflatoxin B&lt;sub&gt;1&lt;/sub&gt;</td>
<td>Aflatoxin B&lt;sub&gt;1&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>Muscle</td>
<td>B</td>
<td>1,100</td>
<td>&lt;1</td>
<td>&gt;1,100</td>
</tr>
<tr>
<td>Muscle</td>
<td>B</td>
<td>550</td>
<td>&lt;1</td>
<td>&gt;550</td>
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<tr>
<td>Muscle</td>
<td>B</td>
<td>280</td>
<td>&lt;1</td>
<td>&gt;280</td>
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<tr>
<td>Muscle</td>
<td>B?</td>
<td>700</td>
<td>&lt;10</td>
<td>&gt;170</td>
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<tr>
<td>Muscle</td>
<td>B</td>
<td>1,360</td>
<td>&lt;10</td>
<td>&gt;136</td>
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<td>Muscle</td>
<td>B</td>
<td>4,300</td>
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<td>&gt;2,150</td>
</tr>
<tr>
<td>Muscle</td>
<td>L</td>
<td>1,860</td>
<td>&lt;1</td>
<td>&gt;1,860</td>
</tr>
<tr>
<td>(Breast)</td>
<td>L</td>
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<td>83 estimated 66 estimated</td>
<td>1,375 1,702</td>
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<td>(Leg)</td>
<td>B</td>
<td>100</td>
<td>av. 0.02</td>
<td>5,000</td>
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<td>556</td>
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<td>5,000</td>
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<td>max. 6.47</td>
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<td>773</td>
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<td>av. 1.59</td>
<td>6,289</td>
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<td>922</td>
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<td>620</td>
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<td>Eggs</td>
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<td>200</td>
<td>av. 0.8</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>max. 2.2</td>
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<td>91</td>
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<td></td>
<td>100</td>
<td>av. 0.2</td>
<td>500</td>
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<td>max. 0.4</td>
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<td>250</td>
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<tr>
<td>Eggs</td>
<td>L</td>
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<td>&lt;1</td>
<td>&gt;2,700</td>
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<tr>
<td>Study 3</td>
<td>Kratzer et al., 1969; Keyl et al., 1970; Garrett et al., 1968</td>
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<td>Study 4</td>
<td>Smith et al., 1965a; Smith et al., 1965b</td>
<td></td>
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<td>Study 5</td>
<td>Abrams, 1965</td>
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<td>Study 6</td>
<td>Platanow, 1965; Smith et al., 1965b</td>
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<td>Study 7</td>
<td>VanZytveld, 1968</td>
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<td>Study 8</td>
<td>Sawhney et al., 1973; Mabee, 1972</td>
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<td>Study 9</td>
<td>Mabee, 1972; Mabee Telcon</td>
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<td>Study 10</td>
<td>Mintzlaff et al., 1974</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study 11</td>
<td>Pons et al., 1974</td>
<td></td>
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</tbody>
</table>
### TABLE V

Average Ratios of Feed Levels of Aflatoxin B$_1$ to Edible Tissue Levels of Aflatoxin B$_1$ and M$_1$

Average derived from considering each of the studies summarized in Tables I-IV as a single data point

<table>
<thead>
<tr>
<th>Animal</th>
<th>Edible Tissue</th>
<th>Aflatoxin in Tissue</th>
<th>Feed to Tissue Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef Cattle</td>
<td>liver</td>
<td>B$_1$</td>
<td>14,000</td>
</tr>
<tr>
<td>Dairy Cattle</td>
<td>milk</td>
<td>M$_1$</td>
<td>300</td>
</tr>
<tr>
<td>Swine</td>
<td>liver</td>
<td>B$_1$</td>
<td>800</td>
</tr>
<tr>
<td>Layers</td>
<td>eggs</td>
<td>B$_1$</td>
<td>2,200</td>
</tr>
<tr>
<td>Broilers</td>
<td>liver</td>
<td>B$_1$</td>
<td>1,200</td>
</tr>
</tbody>
</table>
**TABLE VI**

Occurrence of Aflatoxin M<sub>1</sub> in Dairy Products

<table>
<thead>
<tr>
<th>Country (Year)</th>
<th>Types of Samples Examined</th>
<th>No. of Samples Examined</th>
<th>Percent (%)</th>
<th>Range of Levels Found (ng/ml)</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Africa (1968)</td>
<td>Market milk</td>
<td>21</td>
<td>24%</td>
<td>&lt;0.02-0.2</td>
<td>Purchase et al (1968)</td>
</tr>
<tr>
<td>United States (1973)</td>
<td>Cottage cheese, dry curd,</td>
<td>320</td>
<td>8%</td>
<td>0.05-0.5</td>
<td>FDA (1973)</td>
</tr>
<tr>
<td></td>
<td>nonfat dry milk, evaporated milk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West Germany (1972)</td>
<td>Dried milk</td>
<td>166</td>
<td>5%</td>
<td>0.07-0.2</td>
<td>Neumann-Kleinpaull and Terplan (1972)</td>
</tr>
<tr>
<td>West Germany (1974)**</td>
<td>Dried milk</td>
<td>120</td>
<td>62%</td>
<td>0.02-0.4</td>
<td>Jung and Hanssen (1974)</td>
</tr>
<tr>
<td>United States (1974-5)</td>
<td>Cheeses imported from Europe</td>
<td>156</td>
<td>8%</td>
<td>0.1-1.0 ng/g cheese</td>
<td>Unpublished FDA report.</td>
</tr>
</tbody>
</table>

* All levels reported on fluid milk basis

**Samples picked up at monthly intervals over 1 1/2 year period."
REPORT OF THE COMMITTEE ON ENVIRONMENTAL RESIDUE

Chairman: H. G. Geyer, Washington, DC
Co-Chairman: George T. Edds, Gainesville, FL

A total of seven (7) Committee members and five (5) guests attended this initial meeting.

The term “environmental residues” is intended to exclude drugs as these are considered by the Pharmaceutical and Toxicology Committee. Environmental residues include pesticides, metallic poisons, agricultural fertilizers, biphenyls and other industrial chemicals, certain hormonally active exogenous substances in animals, radioactive substances, harmful molds and mycotoxins. However, only the problem of mycotoxins as they affect livestock, poultry and foods of animal origin will be considered initially.

There is substantial evidence that mycotoxins can and do exert adverse effects on the production of foods of animal origin that are important both economically and in their implications for food safety.

A questionnaire was submitted to the states during 1976 to ascertain diagnostic laboratory services that are available for the quantitation of mycotoxins. A total of 24 of the 50 States responded. Of the respondents, 17 had mycologists, 20 had chemists and 17 determine mycotoxins by officially recommended laboratory methods.

It is apparent that the laboratory testing and educational needs of the veterinary profession and allied professions serving livestock and poultry producers are inadequately served in the area of mycotoxins, even though there is a significant body of knowledge on specific molds and mycotoxins.

The Committee recommends the following actions:

1. Adequate public support of research to determine the biological effects of specific mycotoxins and their metabolites.
2. Identification of the information needed by laboratory diagnosticians, practicing veterinarians, extension specialists, livestock producers and others on mycotoxicoses and develop educational and training programs that will fulfill this need.
3. Evaluation of the adequacy of laboratory facilities, capabilities and methods in actual use for diagnosing mycotoxicoses as a basis for identifying appropriate research and
educational priorities. While "black light" ultraviolet excitation of fluorescence is recognized as a useful screening test of suspected aflatoxins, its proper use requires specialized training and further definitive testing for verification and quantitation.

4. Development of recommendations for methods to utilize feeds contaminated with mycotoxins as an alternative to their destruction.

The Animal and Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture should take responsibility to assist the States by providing training for laboratory diagnosticians in mycotoxin assay and to provide appropriate laboratory reference standards. Public funding should be requested and obtained for these purposes.

In furthering the objectives of this Committee the following resolution is submitted for consideration and appropriate action by the Executive Committee.
EPIDEMIOLOGICAL REPORT OF A TUBERCULOSIS OUTBREAK IN INDIANA AND ILLINOIS

Harold E. McCoy, DVM*

Special recognition must be given to Mr. Wayne R. Cooper, Registrar, American Angus Association, St. Joseph Missouri.

Complete cooperation was received from the American Angus Association as to the detailed registration transfers of individual animals and complete printouts of all transfers from many herds. The epidemiology of this outbreak would have been impossible without this cooperation due to the lack of records of the original source herd.

I will describe with the assistance of seven overhead transparencies the outbreak.

Transparencies

1 and 2 will describe the epidemiology the 6-35 traceback to the herd.
3 will delineate the testing procedure for the task force
4 epidemiology of the Indiana trace
5 epidemiology of the Illinois trace
6 final statistics for Illinois and Indiana
7 final total for the task force

Special credit for an outstanding task force operation must be given to:

Dr. Jack Winslade, Co-ordinator
Dr. Norman Decker, Indiana
Mr. L. Held, Illinois
Mrs. Alice Chittum, Office Manager
Along with many State and Federal Veterinarians and Livestock Inspectors

*Tuberculosis epidemiologist, Northern Region USDA, APHIS, VS

459
Indiana

6-4 A. Herds

Heard dispersed 5-25-1971

Many 6-4B's to Kentucky

98 tested 8 Reactors 2 Lesioned

1 Cow 1 Bull calf 1969

1 Bull calf 1969

6-35

29 Reactors 28 Lesioned

6-35

9 Reactors 2 Lesioned

4 Animals depopulated Co mingled

6-35 & 6573

Dated 12-17-75

6-4 B Herds

McCoy
PROCEDURES FOR TRACING EXPOSED ANIMALS

1. Quarantine entire herd.
2. Depopulated exposed w/indemnity (or) test exposed animal(s) only - 0.2 cc Cervical.
   Read test in 72 hours.
   Any response that can be seen, felt, or measured, classify as Reactor.

   Reactor
   Post Reactor
   Lesions
   No Gross Lesions
   Submit to VSL
   Test remainder of herd 0.1 cc Caudal Fold
   If negative, no further testing necessary.
   Quarantine is released. No C&D.

   Compatible
   No Significant Findings
   Test herd 0.2 cc Cervical
   Tag & Brand any reactors
   C&D within 15 days after removal of reactors
   Retest 60 days 0.2 cc Cervical or depopulate

   Negative - Try to depopulate exposed with indemnity

   Test remainder of herd - 0.1 cc Caudal Fold
   If negative, C&D within 15 days.
   Retest entire herd in 60 days.
   If negative, release quarantine.

Note: Comparative-Cervical can be used on suspects of Caudal Fold tests.

Do not use 0.2 cc Cervical on exposed animal(s) and 0.1 cc Caudal Fold on rest of herd at the same time.

Test with Caudal Fold only after reading 0.2 cc Cervical test of exposed animal(s).
## Summary—Illinois

<table>
<thead>
<tr>
<th></th>
<th>Week Ending 10/2/76</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Known herds yet to be tested</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Unknown herds yet to be tested</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6-4 incomplete)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Complete herd tests</td>
<td>1</td>
<td>118</td>
</tr>
<tr>
<td>4. Incomplete herd tests</td>
<td>0</td>
<td>26</td>
</tr>
<tr>
<td>5. Total cattle tested</td>
<td>48</td>
<td>7,438</td>
</tr>
<tr>
<td>6. Total herds with reactors</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>7. Herds with lesioned reactors</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>8. Herds with lab confirmed lesions</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>9. Herds released from quarantine</td>
<td>1</td>
<td>69</td>
</tr>
<tr>
<td>10. Herds depopulated</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>11. Animals depopulated</td>
<td>0</td>
<td>581</td>
</tr>
<tr>
<td>12. Total reactors</td>
<td>0</td>
<td>96</td>
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## Summary—Indiana

<table>
<thead>
<tr>
<th></th>
<th>Week Ending 10/2/76</th>
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</thead>
<tbody>
<tr>
<td>1. Known herds yet to be tested</td>
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<td></td>
</tr>
<tr>
<td>2. Unknown herds yet to be tested</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6-4 incomplete)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Complete herd tests</td>
<td>1</td>
<td>335</td>
</tr>
<tr>
<td>4. Incomplete herd tests</td>
<td>1</td>
<td>123</td>
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<tr>
<td>5. Total cattle tested</td>
<td>242</td>
<td>17,788</td>
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<tr>
<td>6. Total herds with reactors</td>
<td>0</td>
<td>68</td>
</tr>
<tr>
<td>7. Herds with lesioned reactors</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>8. Herds with lab confirmed lesions</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>9. Herds released from quarantine</td>
<td>0</td>
<td>267</td>
</tr>
<tr>
<td>10. Herds depopulated</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>11. Animals depopulated</td>
<td>0</td>
<td>114</td>
</tr>
<tr>
<td>12. Total reactors</td>
<td>0</td>
<td>473*</td>
</tr>
</tbody>
</table>

*Total reactors increased to include 39 disclosed prior to establishment of the Tuberculosis Task Force.
FINAL REPORT

TERRE HAUTE TUBERCULOSIS
WEEKLY ACTIVITIES REPORT

Tuberculosis Task Force
35 Southland
Terre Haute, IN

Reported by: October 02, 1976

Week Ending

Summary—Illinois and Indiana

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<thead>
<tr>
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</thead>
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</tr>
<tr>
<td>1. Known herds yet to be tested</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Unknown herds yet to be tested (6-4 incomplete)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Complete herd tests</td>
<td>2</td>
<td>453</td>
</tr>
<tr>
<td>4. Incomplete herd tests</td>
<td>1</td>
<td>149</td>
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<tr>
<td>5. Total cattle tested</td>
<td>290</td>
<td>25,226</td>
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<tr>
<td>6. Total herds with reactors</td>
<td>0</td>
<td>95</td>
</tr>
<tr>
<td>7. Herds with lesioned reactors</td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>8. Herds with lab confirmed lesions</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>9. Herds released from quarantine</td>
<td>1</td>
<td>336</td>
</tr>
<tr>
<td>10. Herds depopulated</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>11. Animals depopulated</td>
<td>0</td>
<td>695</td>
</tr>
<tr>
<td>12. Total reactors</td>
<td>0</td>
<td>569*</td>
</tr>
</tbody>
</table>

*see increase in Indiana total
How does one measure progress, or lack thereof, in a program to eradicate a chronic, insidious disease such as bovine tuberculosis? Do we use the yardstick of comparing the numbers of \textit{M. bovis} herds found in a given fiscal year to previous fiscal years? If we use this measuring tool, we are going backwards in the program because in fiscal year 1974 we found 30 \textit{M. bovis} herds; in fiscal year 1975—47 \textit{M. bovis} herds; and, in fiscal year 1976—52 \textit{M. bovis} herds. Fortunately, the increase in the number of tuberculosis affected herds over the past 3 years is probably due to better and more intensive epidemiology aimed at locating herds earlier than in the past. The task force concept first employed in the Georgia outbreak in fiscal year 1974-75 was continued and expanded in fiscal year 1976. Task forces were established in McHenry County, Illinois, Terra Haute, Indiana, and Beatrice, Nebraska, to cope with outbreaks of bovine tuberculosis in Illinois, Indiana, Kansas, and Nebraska. These task forces included a director, one or more epidemiologists, and sufficient State and Federal veterinarians and animal health technicians to trace and tuberculin test all tuberculosis exposed cattle. The advantage of the task force approach in bovine tuberculosis is that the personnel involved can give their undivided attention to tuberculosis without the long delays in tracing and testing animals that often occur when routine procedures are applied. The sooner we can locate tuberculous herds, the fewer the numbers of exposed animals which may be sold from them to spread and perpetuate the disease. The results of the work of these three task forces is summarized as follows:

*Chief Staff Veterinarian, Tuberculosis Eradication, Hyattsville, MD

**Chief Staff Veterinarian, Tuberculosis Epidemiology, Hyattsville, MD
There has been a dramatic change in the tuberculosis status of the individual States in fiscal year 1976. Five additional States—Colorado, Minnesota, North Dakota, Utah, and Wyoming have reached Accredited Free status this fiscal year bringing the total number of States in this category to 10. The other five Accredited Free States are Maine, Connecticut, New Hampshire, New Mexico, and Rhode Island. There are presently 40 States with Modified Accredited area status, 12 of which have not reported Mycobacterium bovis (M. bovis) in the past 5 years (Figure 1).

As previously mentioned, 52 tuberculous herds were found nationwide this fiscal year (Figure 2). Of these 52 herds, 7 were known to have been previously infected with M. bovis and 45 were newly discovered this year.

Indiana led the country with nine M. bovis herds this year, followed closely by Illinois with eight; Kentucky with seven; Puerto Rico with six; Tennessee with four; Massachusetts and Nebraska with three each; California, Kansas, Missouri, and Florida with two each; and Texas, Louisiana, Oklahoma, and Wisconsin with one each. Three States—Indiana, Illinois, Kentucky and the Commonwealth of Puerto Rico accounted for 30 of the 52 M. bovis herds found. The task force operations in Illinois and Indiana accounted for 15 of the 17 tuberculous herds found in those 2 States.

What methods were used to locate the 45 tuberculosis affected herds initially found in fiscal year 1976? Figure 3 reveals that 17 of these herds were found by tracing tuberculous regular kill slaughter cattle to their herds of origin. This compares to 14 herds located in this way last fiscal year. Tracing exposed cattle sold from affected herds accounted for the location of 19 additional herds, which is one less than the 20 affected herds found in this manner last fiscal year. Last fiscal year, only one affected herd was found by area testing. This year, however, five herds were found by this means—
one by routine testing and four by selected area testing around an *M. bovis* herd. Kentucky found four of their seven herds by this selected area testing. The tracing of purchased animals resulted in the location of two tuberculosis affected herds in fiscal year 1976. Milk ordinance and herd reaccreditation testing located one herd each.

Epidemiology is the major tool we have in eradicating bovine tuberculosis. We are committed for economic and manpower reasons to an eradication program based upon epidemiology. It would require an army of veterinarians and a mint of money to revert to the routine, down-the-road tuberculin testing program of the 1930's and 1940's. Such an approach is neither feasible nor practical at this point in time. We must, therefore, continue to perfect our epidemiologic methods and employ them to find tuberculosis. Figure 4 shows the total number of tuberculous herds found and the number of these herds found by epidemiologic tracing over the past 11 years. It is apparent from this chart that the percentage of affected herds found by epidemiologic methods has steadily increased over this period of time. It is anticipated that this trend will continue in future years.

Figures 5 and 6 show the number of tuberculous herds depopulated in fiscal year 1976. Seven States—Illinois, Kentucky, Louisiana, Missouri, Pennsylvania, Texas, and Wisconsin depopulated every known *M. bovis* herd in the State in fiscal year 1976. For the record, Illinois has depopulated every known *M. bovis* herd in the State for the past 10 years. Illinois, long a leader in bovine tuberculosis eradication, has in the past year, taken another step forward in eradicating the disease. Illinois now has a regulation requiring that any herd in which *M. bovis* has been found must remain under State quarantine as long as the herd remains intact. Cattle from such herds can only move direct to slaughter on permit. This action effectively blocks the sale, for other than slaughter purposes, of tuberculosis exposed cattle from herds where the required regimen of tuberculin testing under Uniform Methods & Rules—Bovine Tuberculosis Eradication—may have failed to eliminate all infection. Of the 37 herds depopulated this fiscal year, 4 resulted from the fact that all of the cattle in the herd were classed as reactors to the tuberculin test. The remaining 33 herds were depopulated as tuberculosis exposed with indemnity.

As mentioned earlier, the success of the program in eradicating bovine tuberculosis hinges, to a large extent, on our epidemiologic prowess. The primary factor in our ability to trace cattle is the degree to which such cattle are individually identified. This fact is very evident in Figure 7, where the traceback success rate of tuberculous regular kill animals is 85 percent on cattle with individual identification, but only 55 percent on cattle with no individual identification. A similar picture is seen in Figure 8, which depicts
the traceback success rate in feeders versus that in adult cattle. The rate of success in traceback of adult cattle is almost exactly twice that in feeder cattle. This is due primarily to the fact that more adult cattle are individually identified than feeder cattle. We define a successful traceback as one where we are reasonably sure we have found the source herd whether additional infection is found in that herd or not.

The total number of investigations completed from regular kill slaughter cattle suspected of being tuberculous declined slightly to 1,628 in fiscal year 1976 from the high of 1,682 in fiscal year 1975. The number of cases that were laboratory confirmed as tuberculosis also declined from 195 in fiscal year 1975 to 167 in fiscal year 1976. The percentage of total granuloma submissions found to be tuberculous has dropped from 23.4 percent in fiscal year 1970 to 10.3 percent in fiscal year 1976.

Even though the total number of cases closed has remained reasonably constant at 1,600 plus for the past two fiscal years. Figures 10 and 11 indicate that many more submissions should be coming in each year. Figure 10 shows that of 174 federally inspected slaughter establishments, each slaughtering over 20,000 cows annually, 60 establishments submitted no samples for at least 1 year. An additional 81 establishments submitted from 1 to 7 cases during fiscal year 1976, and only 33 establishments submitted from 8 to 38 cases. It is, of course, true that there is a difference in the quality of animals slaughtered in these various plants. It is also true, however, that several of the establishments which have not submitted any suspected cases of tuberculosis slaughter a good percentage of cull cattle and should be finding lesions suspicious of being tuberculous. Figure 11 presents a similar picture of 134 establishments slaughtering over 100,000 total cattle annually. One-third of these 134 establishments did not submit any suspected cases of tuberculosis in fiscal year 1976. An additional 64 establishments submitted from 1 to 7 cases, and only 26 establishments submitted 8 to 38 cases. Only regular visits to each slaughter establishment by Veterinary Services and State field personnel can stimulate additional submission of specimens.

The comparative-cervical (c-c) tuberculin test continues to be used at an increased rate as an aid in classifying suspects and deviators to the caudal fold test. According to the c-c test charts submitted to Hyattsville, 1,176 (41 percent) of the 17,493 caudal fold suspects during fiscal year 1976 were retested by the c-c test, with 75 percent of them being retested within 10 days of the caudal fold injection. Twelve of the 52 M. bovis herds were so classified by the c-c test. There are now 572 State and federally employed veterinarians trained and approved to conduct the test (Figure 12). Every
State except Alaska has at least one trained and approved veterinarian.

By tabulation of those c-c tests that were forwarded to staff for review as requested, the test was used a total of 2,317 different times. The leading State was New York, followed closely by Pennsylvania and then California.

In conclusion, we seem to be doing a reasonably good job of controlling bovine tuberculosis, but the progress toward eradication of the disease is painfully slow. If we are to attain the goal of eradication by the target date of 2001, we must redouble our efforts to find every tuberculous slaughter animal, trace that animal to its source herd, and eliminate such herds as possible sources of spread of the disease.
**METHODS OF LOCATING TUBERCULOUS HERDS INITIALLY DETECTED IN FISCAL YEAR 1976**

- Traceback of regular kill slaughter animals (17)
- Tracing exposed cattle from affected herds (19)
- Area testing (5)
- Tracing source of affected herd (2)
- Milk ordinance (1)
- Herd reaccreditation (1)

---

**DETECTING HERDS WITH TB INFECTION**

- All other tuberculin testing
- Epidemiologic tracing

Fiscal Year: 1965 to 1975

U.S. Department of Agriculture
Veterinary Services
Animal and Plant Health Inspection Service
PROPORTION OF TUBERCULOUS HERDS DEPOPULATED
(Fiscal Year 1976)

PROPORTION OF TUBERCULOUS HERDS
FY 1965 THROUGH 1976 AND THOSE DEPOPULATED
167 Tuberculous Cases (Regular Kill)  
Animals Identified and Unidentified  
(Fiscal Year 1976)

113 with Identification
18% unsuccessful
85% successful

54 No Identification
45% unsuccessful
55% successful

167 Tuberculous Cases (Regular Kill)  
By Slaughter Class  
(Fiscal Year 1976)

Feeder
35
57% unsuccessful
43% successful

Adults
132
15% unsuccessful
85% successful
Tuberculosis Eradication

TUBERCULOSIS TRACEBACK INVESTIGATIONS (Regular Kill)

- **Cases Not Tuberculosis**
- **Cases of Tuberculosis**

<table>
<thead>
<tr>
<th>Year</th>
<th>Cases</th>
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<tbody>
<tr>
<td>1970</td>
<td>1025</td>
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<tr>
<td></td>
<td>785</td>
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<tr>
<td>1971</td>
<td>922</td>
</tr>
<tr>
<td></td>
<td>772</td>
</tr>
<tr>
<td>1972</td>
<td>879</td>
</tr>
<tr>
<td></td>
<td>727</td>
</tr>
<tr>
<td>1973</td>
<td>1044</td>
</tr>
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<td>810</td>
</tr>
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<td>1975</td>
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<td>195</td>
</tr>
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<td>1976</td>
<td>1682</td>
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<tr>
<td></td>
<td>1628</td>
</tr>
</tbody>
</table>

U.S. Department of Agriculture, Veterinary Services, Animal and Plant Health Inspection Service

Tuberculosis Eradication

GRANULOMAS SUBMITTED FROM 174 FEDERAL ESTABLISHMENTS SLAUGHTERING OVER 20,000 COWS (FY 1976)

VETERINARY SERVICES LABORATORIES, AMES, IOWA

- **None**
- **1-7 Cases**: 60 Establishments
- **8-38 Cases**: 33 Establishments

U.S. Department of Agriculture, Veterinary Services, Animal and Plant Health Inspection Service
GRANULOMAS SUBMITTED FROM 134 FEDERAL ESTABLISHMENTS SLAUGHTERING OVER 100,000 CATTLE* (FY 1976)

VETERINARY SERVICES LABORATORIES, AMES, IOWA

NONE
1-7 CASES
8-38 CASES

44 ESTABLISHMENTS
*Excluding Calves

64 ESTABLISHMENTS

26 ESTABLISHMENTS

U.S. DEPARTMENT OF AGRICULTURE VETERINARY SERVICES ANIMAL AND PLANT HEALTH INSPECTION SERVICE

Veterinarians Approved* To Conduct Comparative-Cervical Test (As of July 1, 1976)

*TOTAL APPROVED - 572

U.S. DEPARTMENT OF AGRICULTURE VETERINARY SERVICES ANIMAL AND PLANT HEALTH INSPECTION SERVICE
REPORT OF THE COMMITTEE ON
TUBERCULOSIS AND JOHNE'S DISEASE

Chairman: P. L. Smith, Sacramento, CA
Co-Chairman: A. R. McLaughlin, Madison, WI


The Committee on Tuberculosis and Johne's Disease met afternoons on Tuesday and Wednesday. The following reports were made:

1. Symposium on Mycobacterial Infections of Zoo Animals, Front Royal, Virginia, October, 1976—Dr. R. M. S. Temple
2. Report on the meeting of the American Association of Zoo Veterinarians, Committee on Infectious Diseases and Tuberculosis.—Drs. M. S. Silberman and R. M. S. Temple.
3. Mycobacterial Isolations from Zoo Animals—Dr. C. O. Thoen
4. Indiana-Illinois Tuberculosis Task Force—Dr. H. E. McCoy
5. Status of the Comparative Cervical Test—Dr. L. D. Konyha
6. Review on Johne's Disease and Swine Tuberculosis Research—Dr. A. B. Larsen
7. Livestock Conservation Institute, Swine Tuberculosis Survey—Mr. Paul Zillman

Committee discussion covered these reports and other topics on bovine tuberculosis eradication and Johne's disease.

SWINE

The committee recognizes the continuing economic burden swine mycobacteriosis causes the swine industry and related increased consumer costs. The committee is pleased the USDA recently requested the Public Health Service (PHS) to review the disposition of swine carcasses with tuberculosis-like lesions. A report from the Center for Disease Control working group which reviewed the request was discussed. The basic conclusion of the report is that there is no new information at this time which would justify a change in the conclusions and recommendations made by the PHS in 1970.
Based on this report the committee felt no additional recommendations could be made except to urge all involved agencies and industry groups to continue studies to provide sound scientific evidence which may lead to reconsideration of the PHS position.

EXOTIC ANIMALS

An increased awareness of the problem of tuberculosis in exotic animals has evolved during the past few years. The committee commends the National Zoological Park, Washington, D. C., for sponsoring a symposium on mycobacterial infections in zoo animals at Front Royal, Va.

At its annual meeting, the American Association of Zoo Veterinarians (AAZV) endorsed the proposal of their Committee on Infectious Diseases and Tuberculosis to set up the mechanisms for a central reporting system of infectious diseases in zoological animals. The primary initial concern will be tuberculosis. The Tuberculosis and Johne's Disease Committee recommends the USDA offer assistance to the AAZV in accumulating, evaluating, and distributing this data.

The committee commends the AAZV for adopting proposals for standardizing tuberculin testing procedures for primates and hoofed stock before movement. However, the committee felt that a great deal of additional information is needed before uniform procedures could be recommended by the U. S. Animal Health Association for interstate shipment requirements.

The committee feels it is in the best interest of both the zoo and livestock industries that authority to control the interstate movement of zoo animals be with animal health agencies. It is advised that animal health officials should give consideration to enabling laws.

The committee recognizes the need for old tuberculin (O.T.) by zoological collections, primate centers, and research organizations. There is concern that continued production of O. T. will be seriously curtailed after December, 1977, when the USDA contract will be converted to the production of M. bovis PPD. The committee recommends all animal health associations support the AAZV and other organizations in their request of biological firms to continue an adequate production level of O. T.

CATTLE

Because of the nationwide problem of disposal of tuberculin reactors, the Committee recommended at last year's meeting that the USDA conduct or sponsor studies to determine thermal death points of the mycobacterial organisms found in livestock at the time of slaughter. We are pleased to be informed funds have been allocated to meat and poultry inspection for a time-temperature study.
The use of paramedical personnel in surveillance tuberculin testing was reviewed. It was decided that many unanswered questions remained concerning the field application of this concept. It was further decided that trial projects would be evaluated during the next year to determine the effectiveness, types of training, and supervision necessary for the utilization of paramedicals. Dr. A. R. McLaughlin, Chairman, and Dr. J. M. Dick were appointed to a subcommittee to evaluate these trial projects. It is anticipated the regional epidemiologists of Veterinary Services will assist them in their study. The subcommittee was instructed to report their findings and recommendations to the committee members prior to the 1977 meeting.

It was again suggested that the deviator classification of tuberculin test interpretation be dropped. It is still the committee's opinion the deviator classification helps assure adequate reporting of tuberculin test responses.

The subcommittee to study making the tuberculosis comparative cervical (C-C) test a mandatory retest requirement for all suspects reported on their findings. They reported a majority of the states favored retesting of suspects by the C-C test and 42 of 47 responding states felt they had an adequate number of approved veterinarians to conduct C-C tests on all suspects. They recommended the requirement of a C-C test on the retest of suspects if all states are assured adequate capability of conducting the test. They recognized the present change in the USDA Training Program whereby a Veterinary Services staff member no longer need be part of the C-C test training team and the appointment of the Regional Tuberculosis Epidemiologist to assume this responsibility may permit adequate training. The full committee was assured by Veterinary Services that adequate training would be provided at the state level. The subcommittee report and recommendation were accepted. To make the C-C test the only retest procedure, we recommend the following change in the Uniform Methods and Rules—Bovine Tuberculosis Eradication (U.M.R.):

Delete phrase "or caudal tuberculin test" from UMR Part III; Section B; Subsection 1-b. Section B determines the disposition of suspects. Currently reads "b. Retested by the comparative-cervical tuberculin test or caudal fold tuberculin test after 60 days, or" Recommend to read "b. Retested by the comparative-cervical tuberculin test after 60 days, or".

JOHNE'S DISEASE

The committee, along with all animal health agencies and associations, recognizes that Johne's disease contributes a significant
financial loss to the cattle industry. Present diagnostic tests, management procedures, and control measures are inadequate. The committee recommends that all animal health agencies provide support to continuing and increasing the funding of research projects. State animal health officials may assist in this effort by urging qualified institutions in their states to participate in research efforts.

The disease is a recognized major problem, however, adequate prevalence and economic studies have not been made. State animal health agencies with the capabilities to make contributions in these areas are urged to develop dependable information which could support requests for research funding.

The committee recommends that the U. S. Animal Health Association demonstrate its concern by presenting a half-day symposium on Johne's disease at the next annual meeting. If the Executive Committee and program planners agree to this recommendation, the Tuberculosis and Johne's Disease Committee would offer their services to plan the format and schedule speakers.
REPORT OF THE COMMITTEE ON
ANIMAL VIRUS CHARACTERIZATION

Chairman: S. McConnell, College Station, TX
Co-Chairman: C. J. York, La Jolla, CA


In keeping with the Animal Virus Characterization Committee's function to keep the US Animal Health Association informed of developments in virus classification and characterization, Dr. Howard L. Backrack presented in committee session, a briefing on subunit vaccines and comparative molecular biology of the animal groups.

Development and utilization of viral subunit vaccines promises to be one of the most fruitful areas of future vaccine exploitation. Viral subunit vaccines of Influenza A, New Jersey (Swine flu) have been produced and extensively tested as part of the current U.S. influenza program and is particularly recommended for use in children. Hexon subunit Adenovirus vaccines have been successfully used in West Germany.

Experimentally, subunits of turkey herpesvirus has been shown to confer complete immunity to virulent Marek herpesvirus infection. An envelope glycoprotein has been shown to immunize mice against Friend leukemia virus. A similar vaccine for bovine leukemia virus should be theoretically possible. Researchers are actively pursuing possible subunit vaccines against Rhabdoviruses (rabies virus), Paramyxviruses (measles virus), Togaviruses (equine arteritis, hog cholera, etc.), and Picornaviruses (foot-and-mouth disease virus).

The VP₃ (virus protein, type 3) surface protein of FMDV has been shown to produce precipitin and serum neutralizing antibody, and to confer protection against homologous challenge in limited trials. This should facilitate the development of an effective polyvalent FMD vaccine.

The influences of molecular biology on virus characterization and its implications and applications to future viral research for prevention and therapy of viral diseases was discussed. Abstracts of these presentations and recommended re-structuring of the Committee membership are appended. This report is respectfully submitted for Executive Committee consideration.
Recommended changes to USAHA Committee on Animal Virus Characterization

Chairman: E. A. Carbrey, Ames, IA
Co-Chairman: S. McConnell, College Station, TX
Secretary: R. O. Spertzel, Frederick, MD

Deletions:
B. R. Burmester, East Lansing, MI
L. V. Melendez, Washington, DC
D. A. Robinson, Washington, DC
A. S. Greig, Hull, Quebec, Canada
Subunit vaccines have been reported for a number of viruses: the penton and penton fibers of adenovirus, the hemagglutinin and neuraminidase of influenza virus, hemolysin from measles virus, a glycoprotein from rabies virus, surface proteins from the hepatitis B 22 nm particle, proteins from Marek’s disease virus, and a glycoprotein (gp 71) from the envelope of Friend leukemia virus. These subunit vaccines and one for foot-and-mouth disease virus will be discussed.
CLASSIFICATION OF ANIMAL VIRUSES BASED ON MOLECULAR REPLICATIVE PROCESSES

Howard L. Bachrach

Virus replication both mimics and interacts with cellular macromolecular synthetic processes in many ways. Fine distinctions in the classification of viruses are elucidated when the similarities and differences in the synthetic pathways are considered. Controlling factors in the synthetic pathways are the compositions of the environs and, more importantly, of the informational content and synthetic activity of the nucleic acid-containing cores which initiate virus-specific macromolecular syntheses. These principles will be used for illustrating the familial and inter-familial relationships of viruses.

Plum Island Animal Disease Center, Agricultural Research Service, U. S. Department of Agriculture, Greenport, New York 11944

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81st ANNUAL MEETING
October 16-21, 1977
RADISSON HOTEL, DOWNTOWN
Minneapolis, Minnesota

82nd ANNUAL MEETING
October 27-November 3, 1978
THE STATLER HILTON HOTEL
Buffalo, New York

83rd ANNUAL MEETING
October 28-November 2, 1979
THE TOWN AND COUNTRY HOTEL
San Diego, California