PROCEEDINGS

NINetiETH

ANNUAL MEETING

of the

UNITED STATES ANIMAL
HEALTH ASSOCIATION

THE EXECUTIVE WEST HOTEL
LOUISVILLE, KENTUCKY
October 19-24, 1986
PROCEEDINGS

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ANNUAL MEETING

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UNITED STATES
ANIMAL HEALTH
ASSOCIATION

P. O. Box 28176
Suite 205, 6924 Lakeside Avenue
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THE EXECUTIVE WEST HOTEL
LOUISVILLE, KENTUCKY
October 19–24, 1986
## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Officers and Committees</td>
<td>vii</td>
</tr>
<tr>
<td>Record of Previous Meetings</td>
<td>xxv</td>
</tr>
<tr>
<td>Invocation and Memorial Service — H. F. McCrory</td>
<td>xxv</td>
</tr>
<tr>
<td>Welcome to Kentucky — David E. Boswell</td>
<td>xxvii</td>
</tr>
<tr>
<td>Response to Welcome — Michael R. Marshall</td>
<td>xxiv</td>
</tr>
<tr>
<td>Introduction of Featured Speaker — N.W. Kruse</td>
<td>xxxv</td>
</tr>
<tr>
<td>The Livestock Industry: Headed Down An Untraveled Road —</td>
<td>xxxvi</td>
</tr>
<tr>
<td>Charles P. Schroeder</td>
<td>xliii</td>
</tr>
<tr>
<td>Address of the President-Elect — John F. Hudelson</td>
<td>xlv</td>
</tr>
<tr>
<td>Remarks of the President — N. W. Kruse</td>
<td>xlvii</td>
</tr>
<tr>
<td>Report of the Secretary-Treasurer — J.C. Shook</td>
<td>xlvii</td>
</tr>
<tr>
<td>Message by the Incoming President of AAVLD — F. R. Robinson</td>
<td>lii</td>
</tr>
<tr>
<td>Remarks by the President of AAVLD — H. S. Gosser</td>
<td>liii</td>
</tr>
<tr>
<td>APHIS Animal Health Award — Presented by J. W. Glosser, D. V. M.</td>
<td>lv</td>
</tr>
<tr>
<td>Associate Administrator, APHIS, VS, USDA</td>
<td>lv</td>
</tr>
<tr>
<td>Report of the Committee on Nominations and Resolutions —</td>
<td>lix</td>
</tr>
<tr>
<td>David. U. Walker, et al.</td>
<td>1</td>
</tr>
<tr>
<td>Report of the Committee on Animal Welfare</td>
<td>12</td>
</tr>
<tr>
<td>E. Mickey Stewart, et al</td>
<td>16</td>
</tr>
<tr>
<td>Report of the Committee on Infectious Diseases of Cattle —</td>
<td>26</td>
</tr>
<tr>
<td>V. A. Seaton, et al</td>
<td>26</td>
</tr>
<tr>
<td>Report of the Committee on Environmental Residues —</td>
<td>42</td>
</tr>
<tr>
<td>T. M. Wilson, et al</td>
<td>45</td>
</tr>
<tr>
<td>Report of the Committee on Epizootic Attack — Joe Finley, Jr., et al</td>
<td>49</td>
</tr>
<tr>
<td>Report of the Committee on Import-Export — Clint Booth, et al</td>
<td>51</td>
</tr>
<tr>
<td>Report of the Committee on Parasitic Diseases and Parasiticides —</td>
<td>53</td>
</tr>
<tr>
<td>M. G. Scroggs, et al</td>
<td>57</td>
</tr>
<tr>
<td>Report of the Committee on Pharmaceuticals, Pesticides and Related</td>
<td>58</td>
</tr>
<tr>
<td>Toxicology — G. D. Lindsey, et al</td>
<td>67</td>
</tr>
<tr>
<td>Report of the Committee on State Federal Relations —</td>
<td>73</td>
</tr>
<tr>
<td>John F. Hudelson, et al</td>
<td>73</td>
</tr>
<tr>
<td>Report of the Committee on Transmissible Diseases of Swine —</td>
<td>73</td>
</tr>
<tr>
<td>J. P. Kluge, et al</td>
<td>73</td>
</tr>
<tr>
<td>Report of the Committee on Zoological Animals — M. S. Silberman, et al</td>
<td>73</td>
</tr>
<tr>
<td>ANIMAL DISEASE SURVEILLANCE</td>
<td>73</td>
</tr>
<tr>
<td>Economics of Disease and Its Effect on Disease Surveillance —</td>
<td>73</td>
</tr>
<tr>
<td>Bob Bohlender</td>
<td>73</td>
</tr>
<tr>
<td>National Animal Health Monitoring System Evaluation of List Frames</td>
<td>73</td>
</tr>
<tr>
<td>For Disease Surveillance Sampling of California Beef Cattle and</td>
<td>73</td>
</tr>
<tr>
<td>Comparison of NAHMS Pilot Project With Retrospective Interview Data —</td>
<td>73</td>
</tr>
<tr>
<td>C. Danaye-Elmi, I. A. Gardner, D. W. Hird and W. W. Utterback</td>
<td>73</td>
</tr>
<tr>
<td>The National Animal Health Monitoring System (NAHMS): An Early</td>
<td>73</td>
</tr>
<tr>
<td>Assessment — L. J. King</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>73</td>
</tr>
</tbody>
</table>
NAHMS: Validation of Disease Diagnoses in Feedlot Cattle —
D. W. MacVean, M. D. Salman and G. R. Frank ................................................. 92
Report of the Committee on Animal Disease Surveillance —
C. M. Hibbs, et al ........................................................................................................ 103

BIOLOGICS

Genetic Engineering of Novel Animal Virus Vaccines — Saul Kit .................. 105
Vectors of Animal Vaccines — J. L. Callis ................................................................. 127

CATTLE

Bluetongue and Bovine Leukosis

Veterinary Management of an Artificial Insemination Center Containing
Bluetongue Seropositive Bulls —
D. R. Monke, W. D. Hueston and J. W. Call ........................................................... 139
Studies on the Control of Bovine Leukosis Virus Infection in the
Northwestern United States — J. F. Evermann, R. F. DiGiacomo,
E. Studer, R. L. Darlington and S. Hopkins ............................................................. 144
Report of the Committee on Bluetongue and Bovine Leukosis —
B. I. Osburn, et al ........................................................................................................ 154

Brucellosis

Brucella abortus Strain 19 Vaccination of Adult Beef Cattle and the
Description and Evaluation of an Enzyme-Linked Immunosorbent Assay
Test Used for Brucellosis Screening of Dairy Cattle in Southern
California — D. E. Suther, R. S. Cooper and L. C. Vanderwagen .................. 167
Status Report 1986 — Cooperative State-Federal Brucellosis Eradication
Program — C. J. Nelson and Jan Huber ................................................................. 177

Leptospirosis

National Reference Center for Leptospirosis-Summary of Diagnostic
Activities—September 1, 1985–August 31, 1986 — D. A. Miller ....................... 207

Mastitis

Factors Affecting Somatic Cell Counts in Milk — R. J. Harmon ..................... 219
Mastitis in Beef Cattle — D. N. Rice, E. D. Erickson, G. Ross
and J. Vetterling ......................................................................................................... 226

FOOD ANIMAL HYGIENE

Recent Research on Salmonella in Food Animal Species and Possible
Human Health Implications — C. S. McCain ......................................................... 231

FOREIGN ANIMAL DISEASES

Looking for the Salt Water Pig — F. M. Jones ....................................................... 236
Emergency Programs Progress Report — A. E. Hall ........................................ 241
Report of the Committee on Foreign Animal Diseases — J. L. Hyde, et al .... 246
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Authors/Editors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livestock Identification</td>
<td>Electronic Identification for Animal Health and Livestock Production — S. L. Spahr</td>
<td></td>
<td>270</td>
</tr>
<tr>
<td>Poultry</td>
<td>Characterization of H5N2 Influenza Viruses From Birds In Live Poultry Markets in USA — R. G. Webster, W. J. Bean, Y. Kawaoka and D. Senne</td>
<td></td>
<td>278</td>
</tr>
<tr>
<td></td>
<td>The Fight Against Avian Influenza: A Three-Way Partnership — J. K. Atwell</td>
<td></td>
<td>287</td>
</tr>
<tr>
<td></td>
<td>Report of the Committee on Transmissible Diseases of Poultry and Other Avian Species — R. A. Bankowski, et al</td>
<td></td>
<td>293</td>
</tr>
<tr>
<td>Pseudorabies</td>
<td>PRV Control/Eradication Plan — H. Schroeder</td>
<td></td>
<td>304</td>
</tr>
<tr>
<td></td>
<td>Report of the Committee on Pseudorabies — M. H. Lang, et al</td>
<td></td>
<td>310</td>
</tr>
<tr>
<td>Public Health</td>
<td>The Economic Losses Due to Selected Foodborne Diseases — T. Roberts</td>
<td></td>
<td>336</td>
</tr>
<tr>
<td></td>
<td>Emerging Meat/Poultry-Borne Pathogens — B. N. Bhargava</td>
<td></td>
<td>354</td>
</tr>
<tr>
<td>Salmonella</td>
<td>Salmonella Reduction Program of Animal Protein Producers Industry — L. E. Davis</td>
<td></td>
<td>368</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Salmonella newport</em> in Cattle: An Animal and Human Health Problem — R. E. Pacer, M. C. Thurmond, C. P. Ryan, J. S. Spika and M. E. Potter</td>
<td></td>
<td>374</td>
</tr>
<tr>
<td></td>
<td>Salmonella Serotypes From Animals and Related Sources Reported During Fiscal Year 1985 — K. Ferris, C. D. Murphy and B. O. Blackburn</td>
<td></td>
<td>381</td>
</tr>
<tr>
<td></td>
<td>Report of the Committee on Salmonella — B. S. Pomeroy, et al</td>
<td></td>
<td>397</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Embryo Transfer in the Control of Transmission of Scrapie in Sheep and Goats — W. C. Foote, J. W. Call, T. D. Bunch and J. R. Pitcher</td>
<td></td>
<td>413</td>
</tr>
<tr>
<td></td>
<td>Report of the Committee on Sheep and Goats — M. C. Howard, et al</td>
<td></td>
<td>418</td>
</tr>
<tr>
<td>Tuberculosis and Johne's Disease</td>
<td>Prevalence of <em>Mycobacterium Paratuberculosis</em> Infection in Cattle Culled in the United States — D. L. Whipple</td>
<td></td>
<td>420</td>
</tr>
</tbody>
</table>
Status of the State-Federal Tuberculosis Eradication Program —
Fiscal Year 1986 — R. L. Hosker .................................................. 422
Report of the Committee on Tuberculosis and Johne’s Disease —
S. B. Hurley, et al ................................................................. 438
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B. R. Hillman, Meridian, ID
David A. Jessup, Rancho Cordova, CA
Daryl C. Johnson, Athens, GA
William E. Ketter, Olney, MD
Robert J. Lee, McLean, VA
Calvin W. S. Lum, Aiea, HI
H. A. McDaniel, Silver Spring, MD
Morton S. Silberman, Atlanta, GA
James S. Smith, Columbia, MD
Richard K. Stroud, Madison, WI
C. D. Stumpff, DeSoto, KS
A. B. Thiermann, Ames, IA

Committee on Zoological Animals–1987

Chairman: Dr. M. S. Silberman, Atlanta, GA
Vice Chairman: Dr. R. L. Crawford, Hyattsville, MD

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Jeanne Roush, Washington, DC
K. C. Sherman, Jefferson City, MO
E. Tom Thorne, Laramie, WY
R. J. Yedloutschnig, Southold, NY
<table>
<thead>
<tr>
<th>Date</th>
<th>Place of Meeting</th>
<th>President</th>
<th>Secretary</th>
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</thead>
<tbody>
<tr>
<td>Sept. 27-28, 1897†</td>
<td>Fort Worth, TX</td>
<td>*Mr. C. P. Johnson, Springfield, IL</td>
<td>*Mr. D. O. Lively, Fort Worth, TX</td>
</tr>
<tr>
<td>Oct. 11-12, 1898</td>
<td>Omaha, NE</td>
<td>*Mr. C. P. Johnson, Springfield, IL</td>
<td>*Mr. Taylor Riddle, KS</td>
</tr>
<tr>
<td>Oct. 11-12, 1899†</td>
<td>Chicago, IL</td>
<td>*Mr. C. P. Johnson, Springfield, IL</td>
<td>*Mr. Mortimer Levering, Lafayette, IN</td>
</tr>
<tr>
<td>Oct. 2-3, 1900</td>
<td>Louisville, KY</td>
<td>*Mr. C. P. Johnson, Springfield, IL</td>
<td>*Dr. F. T. Eisenman, Louisville, KY</td>
</tr>
<tr>
<td>Oct. 8-9, 1901</td>
<td>Buffalo, NY</td>
<td>*Dr. E. P. Niles, VA</td>
<td>*Dr. F. T. Eisenman, Louisville, KY</td>
</tr>
<tr>
<td>Sept. 22-23, 1902</td>
<td>Wichita, KS</td>
<td>*Mr. W. H. Dunn, TN</td>
<td>*Mr. Wm. P. Smith, Monticello, IL</td>
</tr>
<tr>
<td>Sept. 22-23, 1903</td>
<td>Denver, CO</td>
<td>*Mr. W. E. Bolton, Woodward, OK</td>
<td>*Mr. Wm. P. Smith, Monticello, IL</td>
</tr>
<tr>
<td>Aug. 23-24, 1904</td>
<td>St. Louis, MO</td>
<td>*Dr. J. C. Norton, AZ</td>
<td>*Mr. Wm. P. Smith, Monticello, IL</td>
</tr>
<tr>
<td>Aug. 15-16, 1905</td>
<td>Guthrie, OK</td>
<td>*Mr. Wm. P. Smith, Monticello, IL</td>
<td>*Dr. S. H. Ward, St. Paul, MN</td>
</tr>
<tr>
<td>Aug. 15-16, 1906</td>
<td>Springfield, IL</td>
<td>*Mr. M. M. Hanks, Quanah, TX</td>
<td>*Dr. S. H. Ward, St. Paul, MN</td>
</tr>
<tr>
<td>Sept. 14-16, 1907</td>
<td>Richmond, VA</td>
<td>*Dr. D. F. Luckey, Columbia, MO</td>
<td>*Dr. S. H. Ward, St. Paul, MN</td>
</tr>
<tr>
<td>Sept. 14-16, 1908</td>
<td>Washington, DC</td>
<td>*Dr. Charles G. Lamb, CO</td>
<td>*Dr. C. E. Cotton, St. Paul, MN</td>
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<tr>
<td>Sept. 13-15, 1909+</td>
<td>Chicago, IL</td>
<td>*Dr. W. H. Dalrymple, Baton Rouge, LA</td>
<td>*Dr. C. E. Cotton, St. Paul, MN</td>
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<tr>
<td>Dec. 5-7, 1910</td>
<td>Chicago, IL</td>
<td>*Dr. C. E. Cotton, St. Paul, MN</td>
<td>*Mr. J. J. Ferguson, Chicago, IL</td>
</tr>
<tr>
<td>Dec. 5-6, 1911</td>
<td>Chicago, IL</td>
<td>*Dr. John F. Devine, Goshen, NY</td>
<td>*Mr. J. J. Ferguson, Chicago, IL</td>
</tr>
<tr>
<td>Dec. 3-5, 1912</td>
<td>Chicago, IL</td>
<td>*Dr. Macyck P. Ravenel, Madison, WI</td>
<td>*Mr. J. J. Ferguson, Chicago, IL</td>
</tr>
<tr>
<td>Dec. 2-4, 1913</td>
<td>Chicago, IL</td>
<td>*Dr. Peter F. Bahnsen, Atlanta, GA</td>
<td>*Mr. J. J. Ferguson, Chicago, IL</td>
</tr>
<tr>
<td>Feb. 16-18, 1914</td>
<td>Chicago, IL</td>
<td>*Dr. S. H. Ward, St. Paul, MN</td>
<td>*Mr. J. J. Ferguson, Chicago, IL</td>
</tr>
<tr>
<td>Dec. 2-3, 1915</td>
<td>Chicago, IL</td>
<td>*Dr. J. I. Gibson, Des Moines, IA</td>
<td>*Mr. J. J. Ferguson, Chicago, IL</td>
</tr>
<tr>
<td>Dec. 5-7, 1916</td>
<td>Chicago, IL</td>
<td>*Dr. O. E. Dyson, Springfield, IL</td>
<td>*Mr. J. J. Ferguson, Chicago, IL</td>
</tr>
<tr>
<td>Dec. 3-5, 1917</td>
<td>Chicago, IL</td>
<td>*Dr. J. G. Wills, Albany, NY</td>
<td>*Mr. J. J. Ferguson, Chicago, IL</td>
</tr>
<tr>
<td>Dec. 2-4, 1918</td>
<td>Chicago, IL</td>
<td>*Dr. M. Jacob, Knoxville, TN</td>
<td>*Dr. S. H. Ward, St. Paul, MN</td>
</tr>
<tr>
<td>Dec. 1-3, 1919</td>
<td>Chicago, IL</td>
<td>*Dr. G. W. Dumphry, Lansing, MI</td>
<td>*Dr. S. H. Ward, St. Paul, MN</td>
</tr>
<tr>
<td>Nov. 29-30–Dec. 1, 1920</td>
<td>Chicago, IL</td>
<td>*Dr. S. F. Musselman, Frankfort, KY</td>
<td>*Dr. D. M. Campbell, Chicago, IL</td>
</tr>
<tr>
<td>Nov. 28-30, 1921</td>
<td>Chicago, IL</td>
<td>*Dr. W. F. Crewe, Bismarck, ND</td>
<td>*Dr. D. M. Campbell, Chicago, IL</td>
</tr>
<tr>
<td>Dec. 6-8, 1922</td>
<td>Chicago, IL</td>
<td>*Dr. T. E. Munce, Harrisburg, PA</td>
<td>*Dr. Theo. Burnett, Columbus, OH</td>
</tr>
<tr>
<td>Dec. 5-7, 1923</td>
<td>Chicago, IL</td>
<td>*Dr. W. J. Butler, Helena, MT</td>
<td>*Dr. Theo. Burnett, Columbus, OH</td>
</tr>
<tr>
<td>Dec. 3-5, 1924</td>
<td>Chicago, IL</td>
<td>*Dr. J. G. Ferneyhough, Richmond, VA</td>
<td>*Dr. O. E. Dyson, Kansas City, MO</td>
</tr>
<tr>
<td>Dec. 2-4, 1925</td>
<td>Chicago, IL</td>
<td>*Dr. J. H. McNeil, Trenton, NJ</td>
<td>*Dr. O. E. Dyson, Kansas City, MO</td>
</tr>
<tr>
<td>Dec. 1-3, 1926</td>
<td>Chicago, IL</td>
<td>*Dr. John R. Mohler, Washington, DC</td>
<td>*Dr. O. E. Dyson, Wichita, KS</td>
</tr>
<tr>
<td>Nov. 30–Dec. 1-2, 1927</td>
<td>Chicago, IL</td>
<td>*Dr. L. Van Es, Lincoln, NE</td>
<td>*Dr. O. E. Dyson, Wichita, KS</td>
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<tr>
<td>Dec. 5-7, 1928</td>
<td>Chicago, IL</td>
<td>*Dr. C. A. Cary, Auburn, AL</td>
<td>*Dr. O. E. Dyson, Wichita, KS</td>
</tr>
<tr>
<td>Dec. 4-6, 1929</td>
<td>Chicago, IL</td>
<td>*Dr. Chas. G. Lamò, Denver, CO</td>
<td>*Dr. O. E. Dyson, Wichita, KS</td>
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<tr>
<td>Date</td>
<td>Place of Meeting</td>
<td>President</td>
<td>Secretary</td>
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<tr>
<td>Dec. 3-5, 1930</td>
<td>Chicago, IL</td>
<td>*Dr. A. E. Wight, Washington, DC</td>
<td>*Dr. 0. E. Dyson, Wichita, KS</td>
</tr>
<tr>
<td>Dec. 2-4, 1931</td>
<td>Chicago, IL</td>
<td>*Dr. J. W. Connaway, Columbia, MD</td>
<td>*Dr. 0. E. Dyson, Wichita, KS</td>
</tr>
<tr>
<td>Nov. 30-Dec. 1-2, 1932</td>
<td>Chicago, IL</td>
<td>*Dr. Peter Malcolm, Des Moines, IA</td>
<td>*Dr. 0. E. Dyson, Wichita, KS</td>
</tr>
<tr>
<td>Dec. 6-8, 1933</td>
<td>Chicago, IL</td>
<td>*Dr. E. T. Faulder, Albany, NY</td>
<td>*Dr. 0. E. Dyson, Wichita, KS</td>
</tr>
<tr>
<td>Dec. 5-7, 1934</td>
<td>Chicago, IL</td>
<td>*Dr. T. E. Robinson, Providence, RI</td>
<td>*Dr. O. E. Dyson, Wichita, KS</td>
</tr>
<tr>
<td>Dec. 4-6, 1935</td>
<td>Chicago, IL</td>
<td>*Dr. Edward Records, Reno, NV</td>
<td>*Dr. O. E. Dyson, Wichita, KS</td>
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<tr>
<td>Dec. 2-4, 1936</td>
<td>Chicago, IL</td>
<td>*Dr. Walter Wisnicky, Madison, WI</td>
<td>*Dr. L. Enos Day, Chicago, IL</td>
</tr>
<tr>
<td>Dec. 1-3, 1937</td>
<td>Chicago, IL</td>
<td>*Dr. R. W. Smith, Concord, NH</td>
<td>*Dr. L. Enos Day, Chicago, IL</td>
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<tr>
<td>Nov. 30-Dec. 1-2, 1938</td>
<td>Chicago, IL</td>
<td>*Dr. D. E. Westmoreland, Frankfort, KY</td>
<td>*Dr. L. Enos Day, Chicago, IL</td>
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<tr>
<td>Dec. 6-8, 1939</td>
<td>Chicago, IL</td>
<td>*Dr. J. L. Axby, Indianapolis, IN</td>
<td>Dr. Mark Welsh, College Park, MD</td>
</tr>
<tr>
<td>Dec. 4-6, 1940</td>
<td>Chicago, IL</td>
<td>*Dr. H. D. Port, Cheyenne, WY</td>
<td>Dr. Mark Welsh, College Park, MD</td>
</tr>
<tr>
<td>Dec. 3-5, 1941</td>
<td>Chicago, IL</td>
<td>*Dr. E. A. Crossman, Boston, MA</td>
<td>Dr. Mark Welsh, College Park, MD</td>
</tr>
<tr>
<td>Dec. 2-4, 1942</td>
<td>Chicago, IL</td>
<td>*Dr. I. S. McAdory, Auburn, AL</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Dec. 1-3, 1943</td>
<td>Chicago, IL</td>
<td>Dr. W. H. Hendricks, Salt Lake City, UT</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Dec. 6-8, 1944</td>
<td>Chicago, IL</td>
<td>Dr. J. M. Sutton, Atlanta, GA</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Dec. 5-7, 1945</td>
<td>Chicago, IL</td>
<td>Dr. C. U. Duckworth, Sacramento, CA</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Dec. 4-6, 1946</td>
<td>Chicago, IL</td>
<td>*Dr. William Moore, Raleigh, NC</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Dec. 3-5, 1947</td>
<td>Chicago, IL</td>
<td>*Dr. Will J. Miller, Topeka, KS</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Oct. 15-17, 1948</td>
<td>Denver, CO</td>
<td>*Dr. Jean V. Knapp, Tallahassee, FL</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Oct. 12-14, 1949</td>
<td>Columbus, OH</td>
<td>*Dr. T. O. Brandenburg, Bismarck, ND</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
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<tr>
<td>Nov. 1-3, 1950</td>
<td>Phoenix, AZ</td>
<td>Dr. C. P. Bishop, Harrisburg, PA</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Nov. 14-16, 1951</td>
<td>Kansas City, KS</td>
<td>*Mr. F. E. Mollin, Denver, CO</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Oct. 29-31, 1952</td>
<td>Louisville, KY</td>
<td>Dr. Ralph L. West, St. Paul, MN</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Sept. 23-25, 1953</td>
<td>Atlantic City, NJ</td>
<td>*Dr. T. Childs, Ottawa, Canada</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Nov. 10-12, 1954</td>
<td>Omaha, NE</td>
<td>Dr. T. C. Green, Charleston, WV</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Nov. 16-18, 1955</td>
<td>New Orleans, LA</td>
<td>Dr. H. F. Wilkins, Helena, MT</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Nov. 28-30, 1956</td>
<td>Chicago, IL</td>
<td>Dr. A. L. Brueckner, Baltimore, MD</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Nov. 13-15, 1957</td>
<td>St. Louis, MO</td>
<td>Dr. G. H. Good, Cheyenne, WY</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
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<tr>
<td>Nov. 4-6, 1958</td>
<td>Miami Beach, FL</td>
<td>Dr. John G. Milligan, Montgomery, AL</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
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<tr>
<td>Nov. 15-18, 1959</td>
<td>San Francisco, CA</td>
<td>Mr. F. G. Buzzell, Augusta, ME</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Oct. 17-21, 1960</td>
<td>Charleston, WV</td>
<td>*Dr. J. R. Hay, Chicago, IL</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
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<tr>
<td>Oct. 3–Nov. 1-3, 1961</td>
<td>Minneapolis, MN</td>
<td>*Dr. A. P. Schneider, Boise, ID</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Oct. 30-31, Nov. 1-2, 1962</td>
<td>Washington, DC</td>
<td>Dr. W. L. Bendix, Richmond, VA</td>
<td>*Dr. Dr. R. A. Hendershott, Trenton, NJ</td>
</tr>
<tr>
<td>Date</td>
<td>Place of Meeting</td>
<td>President</td>
<td>Secretary</td>
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<tr>
<td>67. Oct. 15-18, 1963</td>
<td>Albuquerque, NM</td>
<td>*Dr. T. J. Grennan, Jr., Providence, RI</td>
<td>*Dr. R. A. Hendershott, Trenton, NJ</td>
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<tr>
<td>70. Oct. 10-14, 1966</td>
<td>Buffalo, NY</td>
<td>Dr. C. L. Campbell, Tallahassee, FL</td>
<td>*Dr. R. A. Hendershott, Trenton, NJ</td>
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<tr>
<td>71. Oct. 16-20, 1967</td>
<td>Phoenix, AZ</td>
<td>Dr. Grant S. Kaley, Albany, NY</td>
<td>*Dr. R. A. Hendershott, Trenton, NJ</td>
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<tr>
<td>72. Oct. 6-11, 1968</td>
<td>New Orleans, LA</td>
<td>Dr. John F. Quinn, Lansing, MI</td>
<td>*Dr. W. L. Bendix, Richmond, VA</td>
</tr>
<tr>
<td>73. Oct. 12-19, 1969</td>
<td>Milwaukee, WI</td>
<td>Dr. John L. O'Hara, Reno, NV</td>
<td>*Dr. W. L. Bendix, Richmond, VA</td>
</tr>
<tr>
<td>75. Oct. 24-29, 1971</td>
<td>Oklahoma City, OK</td>
<td>*M. D. Mitchell, Pierre, SD</td>
<td>*Dr. W. L. Bendix, Richmond, VA</td>
</tr>
<tr>
<td>76. Nov. 5-10, 1972</td>
<td>Miami Beach, FL</td>
<td>J. C. Shook, Mechanicsburg, PA</td>
<td>*Dr. W. L. Bendix, Richmond, VA</td>
</tr>
<tr>
<td>77. Oct. 14-19, 1973</td>
<td>St. Louis, MO</td>
<td>W. C. Tobin, Denver, CO</td>
<td>*Dr. W. L. Bendix, Richmond, VA</td>
</tr>
<tr>
<td>79. Nov. 2-7, 1975</td>
<td>Portland, OR</td>
<td>*J. E. Andrews, GA</td>
<td>*Dr. W. L. Bendix, Richmond, VA</td>
</tr>
<tr>
<td>80. Nov. 7-12, 1976</td>
<td>Miami Beach, FL</td>
<td>H. E. Goldstein, Columbus, OH</td>
<td>*Dr. W. L. Bendix, Richmond, VA</td>
</tr>
<tr>
<td>81. Oct. 16-21, 1977</td>
<td>Minneapolis, MN</td>
<td>*A. E. Janawicz, Montpelier, VT</td>
<td>*Dr. W. L. Bendix, Richmond, VA</td>
</tr>
<tr>
<td>**82. Oct. 21, Nov. 3, 1978</td>
<td>Buffalo, NY</td>
<td>L. E. Bartlett, Sacramento, CA</td>
<td>*Dr. W. L. Bendix, Richmond, VA</td>
</tr>
<tr>
<td>83. Oct. 28, Nov. 2, 1979</td>
<td>San Diego, CA</td>
<td>T. F. Zweigart, Raleigh, NC</td>
<td>Dr. J. C. Shook, Hyattsville, MD</td>
</tr>
<tr>
<td>84. Nov. 2-7, 1980</td>
<td>Louisville, KY</td>
<td>B. W. Hawkins, Ontario, OR</td>
<td>Dr. J. C. Shook, Hyattsville, MD</td>
</tr>
<tr>
<td>85. Oct. 11-16, 1981</td>
<td>St. Louis, MO</td>
<td>L. W. Hinchman, Indianapolis, IN</td>
<td>Dr. J. C. Shook, Hyattsville, MD</td>
</tr>
<tr>
<td>86. Nov. 7-12, 1982</td>
<td>Nashville, TN</td>
<td>G. B. Rea, Salem, OR</td>
<td>Dr. J. C. Shook, Hyattsville, MD</td>
</tr>
<tr>
<td>88. Oct. 21-26, 1984</td>
<td>Ft. Worth, TX</td>
<td>J. O. Pearce, Jr., Okeechobee, FL</td>
<td>Dr. J. C. Shook, Annapolis, MD</td>
</tr>
<tr>
<td>89. Oct. 27-Nov. 1, 1985</td>
<td>Milwaukee, WI</td>
<td>David U. Walker, Montpelier, VT</td>
<td>Dr. J. C. Shook, Annapolis, MD</td>
</tr>
<tr>
<td>90. Oct. 19-24, 1986</td>
<td>Louisville, KY</td>
<td>N. W. Kruse, Lincoln, NE</td>
<td>Dr. J. C. Shook, Mechanicsburg, PA</td>
</tr>
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</table>

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

H. F. McCrory, D.V.M.
Jackson, Mississippi

Heavenly Father, we thank thee for the honor of being together at the 90th Annual Meeting of the United States Animal Health Association and the 29th Annual Conference of the American Association of Veterinary Laboratory Diagnosticians.

We are so respectful that you have provided us with the wisdom and perseverance to achieve strides towards continued control and eradication of animal and poultry diseases in these United States.

Hopefully, you will guide and assist us in making of decisions and developing policies that will be beneficial and rewarding to the livestock and poultry industry which we serve.

We are so appreciative of the guidance you have provided us in the past. May it continue for this meeting and other Animal Health meetings in the future. These blessings we ask in our Savior’s name

Amen

Memorial Service

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

Each year the United States Animal Health Association takes time to pay tribute to those members and wives who have passed away since your last meeting. They are:

Dr. George C. Cilley—State Veterinarian, New Hampshire — died Nov. 8, 1985.
Mrs. Mary Jo Harding, wife of Mr. Frank Harding — died June 20, 1986.
Mrs. Henrietta L. Armstrong, wife of Mr. John B. Armstrong — died July 5, 1986.
Mrs. Jean Creswell, wife of Dr. Al M. Creswell — died July 15, 1986.

Would everyone please rise and bow your head for a moment of silent prayer.

Amen
It is a genuine privilege for me to have the opportunity to welcome the United States Animal Health Association to Louisville and to Kentucky for its annual national meeting. Obviously, your concerns are our concerns here in the agriculture industry in Kentucky and should you have occasion to require our input at this meeting or at anytime in the future, please feel free to contact us.

I would first like to report to you that Kentucky is on the brink of a breakthrough in the eradication of brucellosis in this Commonwealth. As you know, the Federal Government has indicated that it is getting out of the brucellosis eradication business and will leave that job up to the states and the individual producers.

In the meantime, most states are tightening their borders against the intrusion of the disease through interstate movement of diseased cattle. We in Kentucky are about to institute a brucellosis depopulation plan, through which we will add $600,000 in state funds to those incentives already made available by the Federal Government to encourage farmers with exposed herds to send those animals to slaughter.

This plan, together with a beefed-up stockyard and highway security program should put us very quickly far down the road toward the day when brucellosis is but a memory in the Kentucky livestock industry.

Now, I'm going to have some remarks about farming in Kentucky. If you have been keeping up on the farm crisis in this country, you may know that Kentucky is in relatively much better shape than in just about every other state in the Union. About one percent of Kentucky's farmers have had to accept failure, either through bankruptcy or foreclosure and forced sale.

Let me hasten to say that those are cold stark statistics. In Kentucky, even one farm family having to leave the land they have loved, tilled, cared for, had passed down to them over generations...is one farm family too many.

But consider in the corn belt, farms are failing at an alarming rate...12 to 20 percent.

Now, why are fewer Kentucky farmers failing? It's simple, it is diversity. The Kentucky farmer grows a greater variety of crops and produce, usually in multiples of, say, corn, soybeans, dairy and tobacco, and is
therefore less vulnerable to the problems that beset their counterparts devoted to maybe just one or two row crops.

Now in western Kentucky where producers do tend to limit themselves to just corn or soybeans or milo...we have greater incidents of failure. But across the Commonwealth diversity is the key word.

And there has always been tobacco to further hedge the future.

Tobacco...in the Department of Agriculture we call tobacco the life blood of rural Kentucky. Income from tobacco is what makes the banks open their doors, the farm machinery firms stay in business, the grocery stores function, other businesses survive...tobacco's revenues are what fuel government and services in rural Kentucky and it is what keeps the school doors open.

It's easy to say, "Well, they're just going to have to learn to grow something else because tobacco is bad for health and people must stop smoking."

That may happen someday. But as long as the Federal Government continues to understand the economic value of tobacco to the states and itself...as long as there is a quota system and producers of cigarettes shipped all over the world...as long as that continues, there will be a tobacco industry.

Its demise may come, but not in our lifetime.

Let me ask you this question. Do we take farming itself for granted? Do we automatically assume that it will always be with us, because it always has?

We may as well admit it...we all do.

We just know that when we walk into the supermarket, that dollar loaf of bread and that dollar and a half gallon of milk will be there. We don't stop and think about how it got there, how much it cost to produce, who got most of that bread's dollar...and how much did the farmer earn for his important role in the production of that loaf of bread.

Maybe now is the time to throw out some numbers for you so you can get an impact of what some of these agricultural issues mean to you. You as an American enjoy the cheapest food in the world. You pay only 15.1 percent of your income for food.

Now consider that the American farmer receives only 27 cents of each dollar spent on food in this nation, and place that fact against the reality that truly 21 percent of the work force in this nation holds a job because of farming...23 million Americans whose jobs are linked directly to the existence of agriculture.

In Kentucky, we're talking about nearly 350,000 jobs.

Maybe Daniel Webster knew what he was talking about 140 years ago
when he cautioned “Let us never forget that the most important work of man is tilling the soil.”

Think of the economic importance of agriculture in this way: Just the tobacco industry alone . . . from the production to the processing . . . provides a job for one of every 14 working Kentuckians.

Now those numbers illustrate the importance of agriculture to you and me. Maybe we’ll pause a moment to reflect on the farmer’s importance to our lives . . . to our jobs . . . to the very quality of our lives, during our next visit to the grocery store.

If those are today’s statistics . . . how do they translate into what the future . . . what tomorrow . . . holds for agriculture? Let’s see.

I spoke a few minutes ago about the farm crisis in other parts of America. Of course, we remember farm aid and some of the heart-rending stories about farm failure on a very emotional scale.

Those were not just horror stories . . . they are life . . . today . . . in other parts of this great nation.

We are told by the experts in Washington that we are likely to lose one million farmers by the turn of the century. That will leave us 1.2 million farmers to clothe and feed us.

In Kentucky, where times haven’t been as tough, about three thousand farmers have had to leave the land in the last five years. During the last five years, we have lost a quarter million farmers in this nation . . . that is a thousand a week.

But here’s a quick look at what’s happening out there today.

In Minnesota, half of the farmers are in serious trouble. In Nebraska, nearly 4,000 of that state’s farmers are expected to go out of business this year. In Kansas, one of 18 farmers plan to give up this year. In North Carolina, up to 10,000 farmers may decide to quit before they go ahead with planting this season.

It is difficult to envision the loss of a million farmers from the rural fabric of this nation.

Let me tell you a little bit about what we in the Kentucky Department of Agriculture are doing about some of the problems we see in agriculture in this Commonwealth . . . how we are trying to work to preserve agriculture in Kentucky.

In 1984, we worked with the Kentucky General Assembly to create the Kentucky Agriculture Finance Corporation, through which nearly a million dollars in low-interest loans for land and equipment purchases have been issued to Kentuckians . . . many of them first-time farmers.

Also two years ago, we supported the creation of the Kentucky Grain Insurance Law which indemnifies Kentucky grain producers against financial loss should the grain storage facility in which their produce is
stored go bankrupt. Scores of Kentucky farmers have already benefited from the new law since its inception.

This year, Kentucky farmers are allowed for the first time to sell and promote their products on state property, and this year, vocational agricultural instructors in our schools are upgraded as 12-month teachers... a very important step.

We in the states must do more these days to protect our agricultural industry. I want to say something about the Administration’s Farm Bill and the way it deals with this nation’s most important, most basic industry. The Administration is proposing that agricultural expenditures beginning in 1987 be cut by ten billion dollars — including the Gramm-Rudman reductions — from 54 billion to 44 billion dollars. That’s 18 billion dollars.

Now, picture this: Expenditures in agriculture comprise four percent of our federal budget. Yet 25 percent of all budget reductions proposed this year are squeezed into the agriculture budget cuts. The other 95 percent of the federal budget will absorb the other 75 percent of the cuts.

Now I believe that speaks loudly and clearly about the importance placed on agriculture by the policymakers in Washington.

I heard something the other day that pretty much addresses the plight of the farmer and the often negligent attitude about the importance of his contribution: “Heaven help the family that depends on the farmer for its existence... but heaven help the nation that does not.”

One of the items in the budget for the Kentucky Department of Agriculture this year is an allocation for the design and implementation of a new telephone/computer marketing system whereby Kentucky producers and consumers wanting their products can more easily be connected to satisfy each other’s needs. We produce a Kentucky Hay and Straw Directory each year to attempt to bring this kind of commerce about, as well as a Kentucky Fruit and Vegetable Directory and a Kentucky Livestock Directory.

But often, the producer and the potential buyer never get together and we believe we can put modern technology to work to resolve the problem.

For instance, we read the other day that many of the horse farms in the Bluegrass go to other states to get their high quality alfalfa. There’s work toward a Cooperative Grower’s Association through which more of the needed product can be grown at home. We can help in that process.

We are doing that now in so many areas of the Commonwealth in the cooperative production of fresh fruits and vegetables. In Lexington, in Monticello, in Beattyville... with work going on toward the development of new coops in western and eastern Kentucky.

I mentioned diversity a little bit ago as being responsible for Kentucky’s continued relatively healthy position in agriculture. Working with farmers
to allow them to begin to produce new crops for which there is demand is part of the continuing effort to diversify.

I hope I have given you an inkling as to what the climate for agriculture is here in Kentucky and across the nation. I hope that it will cause you to become a cheerleader for agriculture, if you are not already.

In my campaign for this job three years ago, we developed a slogan which we continue to use to good effect in the Department. "KENTUCKY SOIL TOUCHES ALL OF US." That means that agriculture in Kentucky improves the quality of our lives.

Thanks for allowing me to be with you today. God Bless You.
RESPONSE TO WELCOME
Michael R. Marshall, D.V.M.

Thank you, Commissioner Boswell, for this opportunity to visit the Bluegrass Country of America. On behalf of the United States Animal Health Association, and the American Association of Veterinary Laboratory Diagnosticians, I wish to express our sincere appreciation for your hospitality.

I feel that it is a distinct privilege to live in this great free land of ours, and to be called an American. Many things that are a part of agriculture cause a big lump to appear in the laryngeal region of my throat. Some of those things are:

1. Watching a pair of draft horses hit the tugs and move almost insurmountable weights. They were born and bred to pull and they enjoy the work.

2. The friendship and kinship of a blindman and his seeing eye dog. The two of them together is poetry in motion to me.

3. Watching my kids, and other youngsters raise 4-H stock show steers. Then after 7 or 8 months of caring, feeding, pampering, sleeping with the steer in the barn when the steer is sick, these kids sell this beautiful steer through the auction ring, and shed tears as the steer walks up the loading dock to the truck, and on to the slaughter house. Of course, we as parents know that we are raising responsible children and not just steers.

These examples of team efforts all make America great, and in these economic hard times for agriculture I think we all need to find creative new ways to be of service to our agricultural community and to our fellowmen.

On behalf of America’s Beehive State, I wish to invite all of you to Salt Lake City for our 1987 meeting. I promise you that you’ll enjoy our beautiful city, and we’ll be prepared to show you the autumn ski resorts in the canyons, the State Capitol Building, Temple Square, the world center for genealogical research, as well as many of the things associated with our pioneer heritage.

I have always been impressed with an author named Miguel de Cervantes Saavedra. He was born in Spain in 1547 and published a novel in two parts; the first in 1605 and the second in 1615. We know the novel best because of the modern day play called “Man of La Mancha.” The principle character in the play is Don Quixote, and the action takes place in a Spanish prison. In spite of insurmountable obstacles, Don Quixote remains an optimist and dreams of the “Impossible Dream.” I think that we as livestock leaders in America, owe this optimism to agriculture in this free country of ours.

Thank you again and we will see you in the Great City of Salt.
INTRODUCTION OF FEATURED SPEAKER

N. W. Kruse, D.V.M.

Our speaker this evening is a long time friend and former boss, Mr. Chuck Schroeder, Vice President of Development at the University of Nebraska Foundation.

Born and raised in Hayes and Hitchcock Counties in southwest Nebraska where his family farms and ranches around the town of Palisade.

Graduated from the University of Nebraska in 1973 with a B.S. degree in Animal Science.


Director of the National Cattlemen’s Association 1981–1982.

Director and officer of the Nebraska Stock Growers Association 1977–1983, resigned as President-Elect to join state government.

Served as official judge for breeding cattle at major livestock shows throughout the U.S.

Selected for the Outstanding Young Men of America 1978 and 1981.

Listed among Who’s Who in the Western Livestock Industry.

Served on the Agriculture 2001 Task Force for the University of Nebraska.

Served on the Governor’s Task Force on Ag Finance and Rural Development.

Member of the Board, Nebraska Investment Finance Authority.

Treasurer, Mid-America Agricultural Trade Council.

Member, U.S. District Export Council.

Partner in Schroeder Cattle Company, a diversified family farm/ranch operation producing registered and commercial cattle, grain and forage crops.

Began serving as Special Assistant to the Director of the Nebraska Department of Agriculture in March 1983.

Appointed as Director of the Nebraska Department of Agriculture in March 1985. Resigned effective September 1, 1986 to become Vice President of Development at the University of Nebraska Foundation.

Please welcome Mr. Chuck Schroeder.
THE LIVESTOCK INDUSTRY: HEADED DOWN AN UNTRAVELED ROAD

Prepared for:
The U.S. Animal Health Association Annual Meeting
by:
Charles P. Schroeder
October 20, 1986

I. I am deeply honored at the opportunity to address this very prestigious gathering of America’s best in the field of veterinary medicine. This event is particularly special for me because it celebrates a peak in the career of my friend Norm Kruse and the entire Kruse family.

As most of you know, Dr. Kruse is joined here by his wife, Ruth, brother, Marv, sons, Wayne and Ed, and their families. As I watch their very special relationship, I am struck by an analogy from the world of sport. Many of you may have watched the classic Big Ten match-up between the Michigan Wolverines and the Iowa Hawkeyes on Saturday evening. In their last four meetings, the game has been decided by less than eight points. In this contest, with five seconds remaining, Coach Schembeckler sent in his kicker, a boy named Gillette, and Michigan won by a field goal just as time expired. Now, that was certainly a peak in the career of Mr. Gillette. But, I immediately recalled a televised meeting with Coach Bo Schembeckler and his team in 1982 when he declared, “There are no heroes on this roster. Our success depends not upon any individual’s great performance, but upon the team, the team, the team!”

If I might paraphrase, Dr. Kruse clearly recognizes that key to success and emphasizes “the family, the family, the family” in celebrating this professional peak.

I’m proud to know a leader like that and his emphasis on family strengths is a lesson that ought not be ignored by others in this country who search for answers to many of our societal dilemmas.

Well, I’m excited to be here in Louisville, Kentucky — home of Churchill Downs, southern belles, and Kentucky bourbon. You know, this has got to be one of the few places in the world where the pursuit of faster horses, younger women and older whiskey is taken as a sign of gentility rather than decadence! The sophistication of this group is evident when you choose Louisville, Kentucky, instead of Las Vegas, Nevada, for your annual convention. You get to do all of the same fun things, but answer only half as many questions when you get home!

I had the pleasure of judging some breeding cattle just down the street from this convention site in 1982, and I will never forget the spirit of excitement about the livestock industry which seemed to fill this city in a way I’d not anticipated. In my typical western parochialism, I always assumed that as hat brims narrowed and boot heels flattened back here, enthusiasm for the livestock industry declined commensurately. Obvi-
ously, I was wrong. When Dr. Kruse asked me to come and discuss the future of the livestock industry, I could think of no more appropriate locale than Louisville, Kentucky.

Talking about the future of anything is dangerous and I can assure you that I am not a clairvoyant. So, what I'd like to focus on tonight is not what will happen in the livestock industry, but:

1) what might happen;
2) what we'd like to see happen; and,
3) what, in my opinion, must happen.

II. For those of you who like a traditional approach to prognostications, I would offer the following analysis of what might happen in the relatively near future:

"As all of you know, our cow numbers are the lowest since 1963 and we have not yet begun to rebuild. Our 1986 calf crop of 40.1 million head is the smallest since 1960, and total cattle numbers as of July 1 were the smallest since 1974. Once cow herd expansion begins and replacement heifers are taken away from the feeder cattle pool, supplies will tighten even more.

"The Western Livestock Market Information project says, Although the industry has not yet begun to expand numbers, some hints in the mid-year report from USDA indicated that liquidation may be about to end. Numbers of heifers that actually calved and entered the cow herd during the first half of this year were relatively high, both in terms of actual numbers and in terms of the percentage of the intended replacement heifers reported on January 1.

Conditions are such that the industry may be poised for expansion as early as 1987, and may actually begin expanding numbers by 1988.

"World meat production and trade are forecast to continue rising through 1986, but at a slower pace than in 1985. While poultry and pork output is increasing, beef is declining. Burdensome beef stocks are, however, assuring ample supplies."

There. Now, how about that? Those analyses are available from various sources and will be grabbed up in various ways by producers, marketers, and others like yourselves who rely upon the livestock industry for your economic well-being. Are they valuable? Certainly, if kept in the perspective of a broad look at the industry. But, what is their value in determining the individual decisions of a firm? Practically nothing!

Why? Because, especially in the livestock industry, producers are not a homogeneous lot with similar modes of operation, similar costs, similar markets, or similar reasons for being in the business. Individual livestock operations and the businesses and institutions serving them are, in fact, extraordinarily unique and their success will depend upon accurate assessment of the problems and opportunities facing them individually,
day-by-day, week-by-week, month-by-month as they create their own future.

But, what typically happens? A phone call I received recently pretty well expresses it. A cattle feeder called me and said angrily, “I’m going to sue __________ (an extension ag economist)!” When I asked why, he replied, “He cost me thousands of dollars on cattle I fed in the last few months.” When I inquired further, he said, “The newspaper quoted __________ as saying there would be profit potential in cattle fed during this period, so I filled the lot. But, when I sold ‘em, the banker said I lost $75 a head. Now, the bankers giving me a hard time and I think (the economist) ought to be the one paying for it!”

Well, those of you who work with the public know that such a conversation is not that unusual, but we all fall victim to that logic once in awhile.

You know, Cap Dierks from your membership is running for a seat in the Nebraska legislature; we’re getting ready to elect our first woman governor in Nebraska; and we are really in the political season throughout much of the U.S. Well, politics is a strange game that influences many things we do in this world.

A neighbor of mine is getting along in years and having some health problems, but old Joe is normally out putting up yard signs and passing out bumper stickers for every Democratic candidate in the county. Old Joe has been a lifelong Democrat, active in Democratic party politics at every level and took great delight in identifying himself as a died-in-the-wool Democrat. Well, old Joe had a serious illness a while back, and the doctor called the family together and suggested they pay their last respects. When they entered his hospital room, old Joe motioned to his eldest son and asked that he come close to the bedside. “Son,” Joe said, “I want to make one final request before I go.” “Sure, Dad,” the son replied, “anything.” “Well, son before I go,” Joe said, “I want you to go down to the county court house and change my party registration from Democrat to Republican.” “My gosh, Dad,” the son replied, much taken aback, “why at this late date would you want to change your party registration from Democrat to Republican?” “Because,” Joe said, “if somebody’s got to go, I’d rather it be one of them than one of us!”

Well, as we talk about the future of the livestock industry, we need to begin by recognizing that those of us in the livestock industry have for too long used logic about like old Joe’s when it came to dealing with our problems. When the livestock markets have gone to pot, we’ve blamed everyone from politicians to preachers, speculators to supermarkets, processors to importers, consumer activists to animal welfarists, and the list goes on. Even within our own industry — “Don’t trust those guys at the National Cattlemen’s Association or The National Pork Producers Council, you know they’re just a bunch of fat cats. Don’s support those college
guys, you know they're just a bunch of eggheads. Don't support the check-offs, you know the first thing they'll do with the money is go pay somebody who wears a coat and tie to do the work." (How many times have you been told, "Those programs would be alright if they'd get cow men to run 'em?" Thank goodness Chrysler didn't decide to use the same logic and hire a good mechanic instead of Lee Iacocca to run their company.)

If we expect tomorrow to be better than today, then it's imperative that we start looking to ourselves for the source of our problems, and to ourselves for the source of our solutions. Futurist Carol Christensen says, "The future belongs to those who believe in the future", and truer words were never spoken regarding the livestock industry. For those perennial pessimists, those professional paranoiacs who live day-to-day, week-to-week, and year-to-year waiting, yea searching, for the next Darth Vader to swoop down from the black hole of their ignorance and cause the latest calamity, GOOD-BYE, SO LONG, FAREWELL!

The red meat industry and, consequently, the livestock industry are on the verge of revolution and it will be a bonanza for those who recognize that cutting-edge technology, sophisticated business and financial management, systems-oriented husbandry, and inter-industry cooperation are requirements for success. For others who are shaking their heads and waiting for a return to simpler times, the game is frighteningly close to being called on account of darkness.

You prepare here for some great changes in your industry in the years ahead—great battles in some cases, great breakthroughs in others, and occasional great disappointments. I will suggest that this may become a very significant date in our history as an industry. Two hundred years ago, on October 20, 1786, the U.S. Congress called upon the states to raise armies for possible Indian wars. Americans were beginning the journey west at that point, not very far west as we look at the country now, but they were journeying into unknown territory and it was important that they prepare for likely challenges along the way.

This is a lesson for us in 1986 because, in my opinion, the livestock industry is now embarking on an exciting, treacherous journey for which there is no road map, from which there is no retreat and, just as it was two centuries ago, not everyone is made of the stuff to be a successful pioneer. But, for those who are, there will be tremendous opportunities in many, many fields and the U.S. Animal Health Association certainly will play a role in making this journey successful for many people.

As we look at the future of the livestock/red meat industry, there are those who say:

1) Cow numbers are the lowest since 1963, so we will soon be rebuilding, following similar cycles—

2) Grain is cheap (under $1/bu. this week in NE Iowa), so everyone will be feeding cattle and hogs—
3) The Yankelovich, Skelly and White study showed 33% of consumers are either in the “health oriented” or “active lifestyle” groups and their concern over diet/health issues will keep a lid on red meat demand for the foreseeable future—

In other words, our future is pretty well cut and dried. To that I say, Hogwash!

In a report looking at the future of Nebraska’s beef industry, economist Jim Riley says bluntly, “The cattle cycle is a myth that was developed and flourished in academia,” and, certainly, it has been unsuccessful in predicting industry trends of late. We are not locked into any given scenario, but are faced with a myriad of choices!

What’s really going on out there? Lewis Lehr, former President of the 3M Corporation recently said, “The future belongs to those who see opportunity where others see only problems.” Witness this article headlining the Business Section of the *New York Times* on September 28, 1986, entitled “Can the Cow Make a Comeback?”. In it is described the exciting innovations going on in the red meat industry to capture those “opportunities where others see only problems.” Don’t be calling these folks and telling them the red meat industry is “mature” and “without opportunity.” They’re too busy finding opportunities to talk with you!

Looking more closely at your interests, and those near and dear to my heart and bank balance, this report entitled “Agriculture 2001” states boldly that “science power” will drive change in agriculture over the next twenty years. In livestock, advances in biotechnology will significantly alter the ways in which we produce, but will be accompanied by numerous technological, economic, and social questions.

Well, we will have changes in the economy of the industry, changes in the markets for the livestock and the product, and changes in the technologies touching every facet of the industry. Some of these changes are closer than others and its easy to be consumed in speculation about events of the future, resulting in our paralysis in the present. It is at this point that I like to recall the admonition of Scottish writer George Macdonald who says, “The best preparation for the future is the present well seen to, and the last duty done.” In other words, while we are dreaming of a brighter future, we must also recognize our obligation to act each day in order to move us toward that vision.

I would suggest three areas for emphasis which will help us, in Macdonald’s words, to have “the present well seen to and the last duty done” as we approach this period of rapid change.

1) First, we must place a priority on **Research and Education** in order to push both our knowledge and our access to knowledge further faster than we have in the past. In order to make meaningful progress against the major problems facing the livestock industry today, we must invest both public and private sector dollars in appropriate basic and applied research.
We have barely scratched the surface of potential for progress in production efficiency and product development. We must put our money where our mouth is if we are to attract the brightest and best scientists to work in these areas, carry out the research properly and expeditiously, and get it to work for us.

Likewise, we must take a fresh look at education. An essay was published a short time ago entitled “At the Crossroads,” produced by the Communications Era Task Force. In that essay the statement was made that “education must shift from ‘schooling’ to ‘learning how to learn.’” That’s a big idea about education which is different from the “memorization, regurgitation” concept under which most of us studied. President Kennedy maybe put it best when he said, “Education must prepare us for a future in which the choices to be made cannot be anticipated by even the wisest now among us.”

2) Second, we must place a high priority on providing our people with an abundance of high quality, manageable, affordable Information. Orville Bentley, Assistant Secretary for Science and Education of USDA recently stated, “Regardless of the kind of activity, sound scientific and technical information must be used to guide research, education, and policy formulation if the consumer is to be properly informed, constructive regulatory processes established and the food infrastructure system in trade and commerce served.” In other words, the efficient producer and processor, the effective marketer, and the intelligent consumer should have access to and know how to manage information in the volume we have and will have available.

3) Finally, we must aggressively encourage Innovation production of livestock, in the processing and marketing of that production, in the research and education system which serves the industry, and in the government which both regulates and promotes it.

Changes are occurring rapidly external to the industry, and innovation is the means by which we manage in a way that produces positive results, rather than suffering the negative consequences of changes inflicted upon us.

We must be willing to look for new solutions to old problems, and we must be willing to try new approaches to capture new opportunities. In order to be successful, we must be tolerant of mistakes made as the result of innovation, and intolerant of mistakes made as the result of inaction.

III. Research and education, information, and innovation are investments we can make today in order to prepare for our uncertain future. Those of you who have read Erskine Caldwell’s classic, Tobacco Road, recall the Depression era Georgia sharecropper, Jeeter Lester, who went to bed each evening and arose each morning planning for the cotton crop which he would surely plant if he could obtain the guano, seed, and a mule; a crop whose success would surely lift him from poverty. Each day ended, how-
ever, with no progress being made toward putting in the crop because other minutia of the day constantly interrupted. He remained until his death amid the squallor of his everyday existence, constantly dreaming of a better life, but never converting his dreams into action. The livestock industry of the next several years will have its share of Jeeter Lesters, but like the Depression from which his character was spawned, there will likewise be stories of tremendous success.

I will close by placing our problems and the spirit required for success in a little different perspective. In a recent edition of your newspaper, you may have noticed an obscure article recalling the anniversary of Polish labor leader Lech Walesa and his Solidarity party defying their communist government's order to disband and end their protest of violations of human freedoms which we take very much for granted. This tiny group of rebels stood the world on its ear as they risked punishment, abuse and death for themselves and their families in order to simply say "no" to their oppressors. Their actions, you may recall, prompted Russian troops to amass at the Polish border, ready to quash such an insurrection before it got out of hand in the communist world.

Lech Walesa was frequently imprisoned during this period, but during one of his brief periods of release he was interviewed by an American reporter. The reporter asked, "Why, Mr. Walesa, do you and your small band persist in such an obviously hopeless cause? Surely, you know that you are no match for the military might of your own country, let alone that of the Soviet Union. Why don't you give it up?" Walesa replied calmly, "Certainly, we understand the dangers created by our actions. The military could crush us in the streets if they wished, they could do that easily. But, once they've done that, they cannot force us to think what they want us to think, they can't force us to do what they want us to do, because we have a fortress within us that cannot be overrun."

In that one, brief statement this champion of human dignity recognized that a strong spiritual foundation, the freedom of thought created by education, and the assumption of personal responsibility for positive change are essential to a strong community. A community built on such a foundation cannot be overrun, and I encourage you to let the construction begin in the community of the livestock industry.

Thank you.
ADDRESS OF THE PRESIDENT-ELECT

John F. Hudelson, D.V.M.
Denver, Colorado

Dr. Kruse, Dr. Gosser, members of AAVLD and USAHA, Distinguished Guests, Ladies and Gentlemen: It is a distinct honor and high point in my life to find myself in this position and to express some of my thoughts with you tonight.

I look upon the members of USAHA and AAVLD as the movers, shakers, and leaders in the field of animal health. You have tremendous influence on future developments.

Great changes are taking place in the livestock and agricultural industry and we must be alert to these changes and be progressive in our ideas and programs. We must be especially knowledgeable in the fields of bio-technology and new diagnostic aids. I believe it is extremely important to continue to have a very close relationship between USAHA and AAVLD. We need each other more than ever to keep abreast of the changes that are taking place. We must work together and carefully evaluate our disease control programs for the future.

I see no need for major changes in the way our organization works. Our committee system, as it works today, has been extremely successful and is the backbone of our accomplishments. When we look toward the future, there will be changes in our priorities and we will find it necessary to have some new committees and a new Biotechnology Committee was formed this year with Dr. Mulhern as its chairperson. This is a field with tremendous implications and possibilities. We need to increase the emphasis in this area. Members with expertise in this field are essential in order to influence its future direction, development, and integration into animal health programs. Our organization, through its committee recommendations and resolutions, has a great influence on the animal health, animal welfare and food inspection programs carried out in the United States.

Cooperative state-federal programs have been, and continue to be, an important concept of the animal disease control programs in this country. Adequate disease control programs are dependent on a good state-federal industry relationship. We continually try to do this work under increased fiscal restraints from both the state and federal levels. This makes for a difficult task to continue disease control programs. More fiscal responsibility is being thrust on the states with reduced federal budgets under Gramm-Rudmann. Can we face this challenge and continue to do what is needed to assist the livestock industry on disease control? I am convinced that we will.

We are facing budgetary restraints at all levels of government. With our limited resources, we must take a hard look at programs and there will be a greater need to operate in each state according to priorities. The day is past
when programs are designed to fit each and every state. We need to have federal monies passed to the state level to be combined with state monies to accomplish what is most needed in the various states.

As others have done before me, I want to put emphasis on obtaining more members for our association. Progress has been made but there is still a need for each of us to help. We are really well represented by regulatory and academic members. However, we could use many more new members from industry along with additional practicing veterinarians and scientists in the field of biotechnology. I challenge each of you to obtain at least one new member this next year.

I have faith in the future of this organization and I'm sure that all of you will rise to the challenge to continue to work toward control and eradication of animal diseases. We must maintain our sense of direction toward the purpose of this organization.

Our challenges in Animal Health are greater each year. I know that each of you, through your committee participation will meet these challenges. It is an honor for me to work with you and to be a part of your efforts. Please contact me at any time this next year with your suggestions and advice. Thank you very much.
Dr. John Hudelson, President Elect, USAHA, presents a plaque to outgoing President, Dr. Norman W. Kruse for his contributions and outstanding leadership in 1986.
REMARKS OF THE PRESIDENT

N. W. Kruse, D.V.M.

Lincoln, Nebraska

Members of the United States Animal Health Association and members of the American Association of Veterinary Laboratory Diagnosticians and honor guests.

I sincerely thank you for this recognition serving as president of the United States Animal Health Association. I especially want to thank my wife, Ruth, and the Nebraska Department of Agriculture for being so understanding and cooperative during this past year.

The membership is the real strength of the association and I especially want to thank those members who act as committee chairman and co-chairman for they are the backbone of this association. I want to thank the officers for all the cooperation demonstrated as well as the Executive Committee. I would like to thank Mrs. Ella Blanton and Mrs. Linda Ragland for their wonderful guidance and leadership through the year. They carried us through another year. Thank you again, Ella and Linda.

In my remarks as President Elect, I stated it was high time to eradicate brucellosis. I am proud of the amount of progress we have made in the past year. On February 7, Nevada went from "B" status to "A". May 8, 1986, New Jersey and West Virginia reached free status. May 28 the strip north of Grand Canyon in Arizona was raised to free, and just recently Puerto Rico was raised to free status.

Now looking at the national brucellosis progress in 1986, I would like to quote you a few figures I secured from veterinary services. These are not final until the total analysis is completed.

1. Number of infected herds 1985 — 6985 herds.
   Number of infected herds 1986 — 5256 herds (a decrease of 1729, which is almost a 25% decrease).

2. Number of BRT suspicious herds.
   1985 — 2,275 herds — 1,316 herds tested.
   1985 — 2,239 herds — 1,530 herds tested.
   Which indicates we are doing testing.

3. Number of BRI infected herds.
   1985 — 150 herds.
   1986 — 105 herds.
   Decreased by 30%.

4. Market cattle testing program.
   1985 — 13.7 million cattle tested.
   1986 — 13.13 million cattle tested.

5. Total number cattle tested.
   1985 — 19.4 million.
1986 — 17.7 million.
Reactors disclosed 1985 — 103,000.
1986 — 78,000.

with about 25% fewer reactors.
6. Calves officially calfhood vaccinated.
1985 — 9,341 + 792 head.
1986 — 8,811 + 300 head.

In summarizing, the number of reactor herds have decreased consistently for the past five (5) years and likewise, the number of reactor cattle has consistently decreased for eight (8) years.

This year we appointed a new Biotechnology Committee with Dr. Frank Mulhern as chairman and Dr. Al Strating as co-chairman. We felt that we needed a committee to be aware of the activities in this area and to keep membership of USAHA informed of the new developments. I feel generic engineering is here to stay. Whenever a new technology is developed or introduced, there is a great deal of controversy concerning where it is going. With the expertise of this committee, I am sure they will have a very informative meeting tomorrow morning at 8:30 to 12:30 in the Heather Room.

Every indication is evident that the secretary’s office, as well as the local Arrangements Committee have done extremely well in making plans for a fine meeting here in Louisville. Please join me in making the 90th Annual Session of the USAHA one we will all remember as both productive and enjoyable.

In closing, I would like to thank all of you once again for allowing me the opportunity to serve you as your President.
REPORT OF THE SECRETARY-TREASURER

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

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

The USAHA office has had a good year largely due to the dedicated efforts of our two gals, Ella and Linda. We now have many of our records on the computer and that has been most helpful. Some days Linda threatens to throw the thing out the window, but we have found tranquilizers to be inexpensive. Dr. Park has been most helpful in advising us on the use of the computer and assures us that Linda has made great progress and no longer panics when the word delete is mentioned.

Dr. Kruse has been an outstanding president and leader. The board of directors have been hard working and objective in their management of the affairs of the Association.

The directors have met several times with the board of directors of AAVLD and I believe a great deal of progress and understanding has resulted between the two organizations.

We all appreciate the contribution that Norm and Jay Powers make in managing the registration desk. The registrants are also grateful for the entertainment and hospitality the Ketchum Manufacturing Company and the Hasco Tag Company are providing at our party Wednesday evening. I know everyone attending will have a good time as well as a delicious meal.

The management and staff of the Executive West Hotel have been most cooperative and accommodating and the facilities have been outstanding.

A few housekeeping announcements as usual. All resolutions from committees must be prepared on the forms provided at the workroom and six copies of each resolution turned into Dr. Dave Walker, Chairman of the Resolutions Committee. Dr. Walker is very busy so resolutions may also be dropped off at the registration desk.

Please notify the USAHA office immediately if any members change address. We urge everyone to pay their 1987 dues promptly, preferably while you are here in Louisville.

As a matter of interest we preregistered approximately 500 which is about the same as last year. We think we should and can do better than that. Those who preregister and cannot attend will be refunded if they notify the Richmond office.

The USAHA is financially solvent. Income through October 15, 1986, has exceeded expenditures by approximately $5,000. The annual fiscal report for the calendar year 1986 will be printed in the proceedings. Auditor copies will be provided all members of the executive committee.
Copies are also provided for any members who request it.

We hope you are enjoying this great Kentucky weather and that the meeting this week will be a total success. We look forward to seeing all of you in Salt Lake City next year.

UNITED STATES ANIMAL HEALTH ASSOCIATION
P. O. BOX 28176
SUITE 205, 6924 LAKESIDE AVENUE
RICHMOND, VIRGINIA 23228-0176

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS FOR PERIOD
JANUARY 1, 1986 through DECEMBER 31, 1986

CASH BALANCE - DECEMBER 31, 1986:

Bank of Virginia
Richmond, Virginia

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$105,953.45

Henry R. Budd, Accountant
MESSAGE OF THE INCOMING PRESIDENT OF AAVLD

F. R. Robinson, D.V.M.
West Lafayette, Indiana

President Kruse, President Gosser, Distinguished Guests, Ladies and Gentlemen, I am privileged to be here this evening representing the American Association of Veterinary Laboratory Diagnosticians and in having the opportunity to talk with you about the AAVLD and what I foresee as its direction in the future.

Great strides have been taken by our organization in recent years and my vision of the future is that the AAVLD will continue to grow and prosper, providing its membership with a forum to expand and disseminate knowledge on diagnostic matters on a worldwide basis. The sign of a growing viable organization is its ability to advance during nationally uncertain economic times. In this regard the economic health of some diagnostic laboratories is closely related to the agricultural or petroleum economies. Therefore, some laboratories currently are in an undesirable funding situation. We anticipate that these economic problems soon will be resolved.

The AAVLD made a very important decision this past year in deciding to engage a management firm to conduct the daily business of the organization and coordinate newly developing professional activities. We in the governing body and the management firm are looking forward to increasing our service to the membership and associated discipline groups. The development of a productive AAVLD-management relationship is not going to happen overnight, but is expected to be fully effective in the second or third year of operation.

There have been serious attempts in the last few years to make a more smooth interface between our two organizations, the AAVLD and the USAHA. For the most part this has been effective and useful but has depended to a great extent on concerned individuals in both organizations. My sincere thanks and appreciation go to Drs. John Ragan and David Walker. They have been most helpful and where their understanding and influence has been felt, there has been real progress in making the organizations more compatible. There have been a few rough spots in our association, one with the other. There are advantages to both organizations being compatible, working with one another and attempting to achieve a common purpose. One of the advantages of this symbiotic relationship is to enable members from both organizations to attend both meetings in one trip. In fact many members belong to and are active in both organizations. In addition, the USAHA members attend the AAVLD Scientific Meeting and they are most welcome to do this. As you know, we are starting commercial exhibits this year and the USAHA membership again is most welcome to visit the exhibits sponsored by the AAVLD — the more the better. I believe that it is also self evident that AAVLD members
serve on many USAHA committees and make significant contributions to achieving the goals of the USAHA.

Inevitably there are some disadvantages to the way in which our organizations function. There is a growing need for both organizations to have more time for their own functions. This may eventually serve as a basis for a logical separation and conduct of separate meetings by the two organizations. There are also continuing problems with the selection of meeting sites. The USAHA has unilaterally for the most part selected the meeting sites and the hotel in which the meeting is to be held. I feel that if this is truly a partnership of the two organizations, there should be mutual participation and agreement on the location of future meeting sites. There is also a continuing concern over how registration fees are apportioned. There is a need for a better system of registering for the Annual Meetings and a better means of accounting for and apportioning the fees. The AAVLD has an additional problem that has developed in recent years in that a number of the members arrive for Sunday meetings and do not remain for the scientific sessions. It seems most appropriate for us to begin our registration for the meeting on Sunday morning, rather than later.

The AAVLD is interested in providing more diverse programs to its membership and involving more specialty groups. Currently pathologists, toxicologists, microbiologists and nonveterinary administrators and supervisors are now meeting on Sunday prior to the annual meeting. The current membership would like to encourage the participation of our members in these specialty meetings so that items of specific interest to the specialty group can be discussed and presented as a program.

The idea of one to three day seminars on specific subjects has been discussed a number of times. These conceivably could be held in conjunction with the annual meeting or throughout the year on a regional basis. As an example, the North Central Conference of Veterinary Laboratory Diagnosticians has met on an annual basis for many years and is a well attended program. The meeting this past spring was at Michigan State University; the turnout was quite good and the program excellent.

We wish to expand the eligibility for membership in the AAVLD to a broader community of diagnosticians. This necessarily means that the definition of diagnostician be extended to a broader scope of understanding. Currently our members consist primarily of diagnosticians employed in diagnostic laboratories of one type or other. Discussions among members suggest that other diagnostic disciplines not immediately associated with diagnostic laboratories may be interested in joining our organization (clinical pathologists, radiologists, endocrinologists, pharmacologists, etc.).

It is my hope that you take my comments this evening at face value and my serious attempt to provide a basis for a continuing association of our
two great organizations. I would like no more than for these organizations to continue in an amicable and productive relationship. I think we do have many challenges before us to overcome to maintain this relationship and I am looking forward to working with the officers and membership of both organizations to address these challenges.
REMARKS BY THE PRESIDENT OF AAVLD
H. S. Gosser, D.V.M.
Tifton, GA

President Kruse, President Robinson, Ladies and Gentlemen:

Let me begin by thanking our hosts for the arrangements for this meeting, and for the welcome they have given us to this beautiful state and city. The weather has been cooperative and the facilities are excellent.

It is late and we are near the end of the program, so my remarks will be brief.

A year ago as I stood before this group, I enumerated several areas which needed to be addressed. These issues were studied and several programs have been adopted. These include the arrangements for the commercial exhibits at this meeting which provide an opportunity for our members to see new items available for laboratories, and the employment of a professional management group to assist with the business aspects of the association, which will allow the officers to concentrate their efforts on the scientific aspects of the association. Also, a committee is studying the feasibility of the association sponsoring a refereed journal.

The AAVLD is a wonderful association because of its members and their dedication to the betterment of diagnostic medicine; it has indeed been a pleasure and honor to serve as President. I have had strong support from the membership, as well as the Board of Governors and officers. The past year has been busy but most enjoyable. The officers worked hard; they accepted and fulfilled new responsibilities and set new sights for the AAVLD.

I am indebted to Dr. Robinson who has carried out the responsibilities of both Vice-President and President-Elect, to Dr. Larry Morehouse who continued to provide his knowledge, and experience to the AAVLD and to Dr. Bob Crandell for his enthusiasm, and willingness to serve, and to the entire Board of Governors for their interest and hard work.

I want to recognize and express my appreciation to Dr. James Glosser, Special Assistant to the Administrator of APHIS and Dr. Bob Nervig, Director of NVSL for their interest in establishing stronger communications between NVSL and the veterinary diagnostic laboratories.

Committees are a vital necessary cog for implementing the progressive, constructive policies of the AAVLD. They have been very active and my thanks to their chairmen for their efforts in organizing meetings and preparing reports.

Also, a special thank you to Ms. Donna Dare for organizing the commercial exhibits and insuring their success. I also, have a special thanks for Dr. Harvey Rubin, Director of the Diagnostic Laboratories in Florida
and Past-President of the AAVLD, for his encouragement to me 7 years ago to become active in the AAVLD.

And to Dr. Dave Walker, Dr. John Ragan, Dr. Norman Kruse, and Dr. John Shook of the USAHA, my thanks for their cooperative spirit. However, gentlemen, please remember that certain decisions you make, especially in meeting site selection, directly affect the quality of our program, and we must be included in these decisions.

Louis Pasteur, the French chemist once said, "In the fields of scientific observation, chance favors only the mind that is prepared." Part of the responsibility of the AAVLD is to be sure veterinary laboratory diagnosticians are prepared to support the animal industry. We do this well. However, we must not rest on past laurels. The world waits on no one. We must be bold — set new goals — meet new challenges.

Dr. Robinson is a qualified, dedicated leader and the AAVLD is a group of very talented individuals. I urge you, Dr. Robinson, to use the talents of the membership, and in return, I urge all of us to give you our fullest support.

Again, it has been an honor to be your President. Thank you and good night.
Every year since the mid-1970's, an "Animal Health Award" has been presented by the Administrator of APHIS in conjunction with the annual meeting of the U.S. Animal Health Association. The prime criteria for the award is that the individual must have provided leadership — on both the State and National levels — in advancing animal health programs.

This evening, it's my pleasure to present this year's animal health award to an individual, who like those who have received this award in the past, has made significant contributions to the health of our nation's livestock and poultry industries.

Benjamin S. Pomeroy

Ben Pomeroy is one of the giants of the veterinary profession. His contributions add up to a career of dedication to the Land Grand University concept of excellence in teaching, research and service. Born in St. Paul in 1911, he attended Iowa State University and was awarded the D.V.M. degree in 1933. He received an M.S. degree in 1934 from Cornell University.

Then he accepted an appointment at the University of Minnesota as a Diagnostician. His early career was formed as a poultry diagnostician in the Veterinary Science Department of the Agricultural Experiment Station. His reputation grew as he matured into one of the country's leading poultry health specialists while also participating in the general diagnostic, research and extension programs of the laboratory.

Dr. Pomeroy received his Ph.D. degree from the University of Minnesota in Veterinary Microbiology in 1944. In 1966, he became a Diplomate of the American College of Veterinary Microbiology — a Charter Member, I might add.

He has had a very distinguished career in teaching, research and service. His teaching at the University has been at all levels; undergraduate, graduate and extension education. During the time he was director of graduate studies in Veterinary Microbiology from 1957 to 1978 he advised 36 M.S. candidates, 31 Ph.D. candidates, and 10 postdoctoral students.

Dr. Pomeroy has authored or co-authored over 150 scientific articles on animal and poultry diseases. He has written over 300 popular articles on avian diseases in such magazines as GOBBLES, TURKEY WORLD, and POULTRY DIGEST. He is co-author of the book, "Diseases and Parasites of Poultry." He is contributing author to "Diseases of Poultry" and to a manual sponsored by AAAP entitled "Isolation and Identification of Avian Pathogens."
Ben also has a distinguished administrative service record at the University. He was Professor and Head of the Department of Veterinary Microbiology and Public Health (1953–73), Associate Dean of the College of Veterinary Medicine (1970–74), Coordinator of Alumni and Public Affairs (1974–81), Coordinator of Avian Disease Research Programs (1975–81), and Acting Dean of the College of Veterinary Medicine (1979).

Dr. Pomeroy has been a real advocate of preventive medicine throughout his career — and we in APHIS have been fortunate to have been a recipient of his thinking in this area. He was one of the early pioneers in the establishment of the National Poultry Improvement Plan, which became operative in July of 1935. He remains an active member of the U.S. Animal Health Association, which he joined in 1944. He has been very active on two committees of this Association: Transmissible Diseases of Poultry and Chairman of the Committee on Salmonellosis.

He was the first president of the American Association of Avian Pathologists in 1958 and has been chairman of several of their committees over the years.

He has been advisor to many Federal and State Agencies including:

1. National Academy of Sciences — National Research Council (Committees on Salmonella, Animal Nutrition and Animal Health)
3. Minnesota Board of Animal Health, Advisor on Poultry Health Problems
4. Minnesota Department of Agriculture, Meat Advisory Board 1968–72
5. Minnesota Turkey Growers Association, Chairman, Minnesota Breeder Hen Committee 1952–81
6. National Turkey Federal, Turkey Health Committee 1975–81
   Program Committee 1970–81
7. USDA
   **Poultry Inspection Program Advisory Committee 1960–71
   **APHIS, VS, Advisory Group of Poultry Disease Control 1971–75
   **APHIS, VS, Poultry Health Advisory Committee to Secretary of Agriculture 1976–78
   **APHIS, VS, Scientific Advisory Group for Exotic Newcastle Disease Eradication 1972–86
(and most recently)

** Scientific Advisory Group for Lethal Avian Influenza Eradication Program 1983–86

A list of honors and distinctions he has received include:

- Membership in such honor societies as: Phi Zeta, Phi Kappa Phi, Sigma Xi, Cardinal Key, Scabbard and Blade and Alpha Gamma Rho Professional Fraternity
- Research Award — National Turkey Federation — 1950
- Ranelius Award of Outstanding Research and Service — 1957
- Fellow of Poultry Science Association “Professional Distinction with No Concern for Longevity” 1975
- Stange Awards for Meritorious Service in Veterinary Medicine, Iowa State University — 1977
- Poultry Hall of Fame — 1977
- Service Award — American Association of Avian Pathologists — 1978
- Distinguished Service Award — Minnesota Veterinary Medical Association — 1980
- Public Service Award — American Veterinary Medical Association — 1980
- Distinguished Achievement Citation — Iowa State University Alumni Association — 1981
- Centennial Award of Merit, School of Veterinary Medicine, University of Pennsylvania — 1958
- First Endowed Chair in the College of Veterinary Medicine named in his honor: “Benjamin S. Pomeroy Endowed Chair in Avian Health” — 1985

And finally, he has the following honorary Life Memberships:
- National Turkey Federation — 1959
- Texas Poultry Federation — 1962
- Minnesota Turkey Growers Association — 1967
- Minnesota Veterinary Medical Association — 1975
- American Association of Avian Pathologists — 1978

Ben, it's with a great deal of pleasure that I present you with this certificate, which reads as follows:

“Animal Health Award — Doctor Benjamin S. Pomeroy

“In recognition of your many years of meritorious service to the State of Minnesota and your support of major national disease eradication programs that have contributed significantly to the health of the poultry industry of this country.”
Dr. James W. Glosser, Associate Administrator, APHIS, VS, USDA presents the Animal and Plant Health Inspection Service's award to Dr. Benjamin S. Pomeroy, a giant of the Veterinary profession.
REPORT OF THE COMMITTEE ON NOMINATIONS

President ........................... John F. Hudelson
Denver, Colorado

President-Elect ...................... John A. Cobb
Atlanta, Georgia

First Vice President ................ P. E. Bradshaw
Griggsville, Illinois

Second Vice President .............. M. A. Van Buskirk, Jr.
Harrisburg, Pennsylvania

Third Vice President ............... Joan M. Arnoldi
Madison, Wisconsin

Treasurer ............................ A. B. Park
Annapolis, Maryland

Regional Delegates

Northeast ............................ Everett Bryant
Storrs, Connecticut

                     Victor LaBranche
                     Boston, Massachusetts

North Central ........................ Don Gingerich
Parnell, Iowa

                     Bill Gallagher
                     Highmore, South Dakota

South ............................... Joe Finley, Jr.
Encinal, Texas

                     William Baisley
                     Dalton, Georgia

West ............................... Olin H. Timm
Dixon, California

                     R. H. McCapes
                     Davis, California
RESOLUTIONS
United States Animal Health Association
Passed October 24, 1986
Louisville, Kentucky

Resolution No. 1
Source: Committee on Salmonella and Transmissible Diseases of Poultry and other Avian Species
Subject Matter: Increase Research and Epidemiology Studies to Reduce Salmonella Infections in Livestock and Poultry and Meat and Poultry Products

Resolution
BE IT RESOLVED THAT USAHA recommends that FDA and USDA (ARS, CSRS, APHIS, FSIS and ES) increase their educational, research and epidemiologic efforts through their inhouse research programs, as well as the competitive grants and special grants program, in reducing salmonella infections in livestock and poultry and contamination of meat and poultry products and

BE IT FURTHER RESOLVED THAT improved sanitation and processing procedures be investigated in cooperation with the Animal Protein Producers Industry to reduce salmonella recontamination in rendering plants and in animal and poultry by-products.

Resolution No. 2
Source: Committee on Salmonella and Transmissible Diseases of Poultry and other Avian Species
Subject Matter: Biosecurity Information Systems

Resolution
BE IT RESOLVED THAT USAHA request that Government agencies, including ES, APHIS, ARS, CSRS, FDA, and FSIS, make available a sum of $40,000 to $60,000 to support, in cooperation with the poultry industry, the development of action videotapes demonstrating sound biosecurity practices and providing a basic understanding of their rationale and economic advantages.

Resolution No. 3
Source: Committee on Wildlife Diseases and Transmissible Diseases of Poultry and other Avian Species
Subject Matter: Support for Use of NPIP in Game Birds

Resolution
BE IT RESOLVED THAT the United States Animal Health Association be on record as favoring measures taken by state wildlife agencies to
encourage or require that pen-raised game birds released into the wild meet NPIP standards.

**Resolution No. 4**
Source: Committee on Transmissible Diseases of Poultry and other Avian Species
Subject Matter: Request for USDA to continue the supply of *Pasteurella Multocida* serotyping reagents to state diagnostic laboratories

*Resolution*

BE IT RESOLVED THAT the United States Animal Health Association vigorously request that the USDA continue to provide *Pasteurella multocida* typing sera to state diagnostic laboratories servicing the poultry industry.

**Resolution No. 5**
Source: Committee on Infectious Diseases of Horses
Subject Matter: Potomac Horse Fever

*Resolution*

BE IT RESOLVED THAT the USDA-ARS should measurably increase their scientific investigations of the vector of Potomac Horse Fever.

**Resolution No. 6**
Source: Committee on Epizootic Attack, Foreign Animal Diseases and Parasitic Diseases and Parasiticides
Subject Matter: Embryo Importation and Disease Transfer

*Resolution*

BE IT RESOLVED THAT the USAHA strongly urges the USDA to properly design, fund, and conduct such field trials as necessary to determine the probability of disease transmission in the course of transferring a large number of embryos from infected cattle to susceptible recipients.

**Resolution No. 7**
Source: Committee on Parasitic Diseases and Parasiticides and Epizootic Attack and Foreign Animal Diseases
Subject Matter: Tropical Bont Tick and Heartwater Disease feasibility study in the Caribbean

*Resolution*

BE IT RESOLVED THAT USAHA strongly urges the USDA and USAID to fully support the principal of eradication of *Amblyomma Variegatum* as presented in the feasibility proposal and that these agencies cooperate fully with the territories and islands in the Caribbean, inter-
national organizations and other interested governments to implement the strategies of the feasibility proposal.

Resolution No. 8
Source: Committee on Epizootic Attack, Foreign Animal Diseases and Parasitic Diseases and Parasiticides
Subject Matter: Diagnostic Reagents for FAD
Resolution
BE IT RESOLVED THAT USAHA encourages and supports a joint feasibility study by APHIS, ARS and AAVLD for the distribution of safe reagents needed to diagnose foreign animal diseases to AAVLD fully-accredited laboratories or other laboratories approved by APHIS.

Resolution No. 9
Source: Committee on Wildlife Diseases
Subject Matter: Brucellosis in Yellowstone National Park
Resolution
BE IT RESOLVED THAT the United States Animal Health Association urges the Department of Interior, National Park Service to actively and in good faith cooperate with the United States Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services.
1) To discuss and evaluate the bison brucellosis problem in Yellowstone National Park,
2) To fund field trial and research projects directly applicable to solving this problem, and
3) To study ways and make plans to contain and eliminate the reservoir of brucellosis that exists in Yellowstone National Park and to expeditiously put these plans into effect.

Resolution No. 10
Source: Committee on Infectious Diseases of Horses
Subject Matter: Potomac Horse Fever
Resolution
BE IT RESOLVED THAT USAHA strongly urges the U.S. Department of Agriculture to take all necessary steps to assure that exportation of horses be continued without interference by the incidence of Potomac Horse Fever in the U.S.

Resolution No. 11
Source: Committee on Epizootic Attack
Subject Matter: Laboratory Preparedness for Diagnosis of Exotic Diseases.
Resolution

BE IT RESOLVED THAT USAHA requests that the Foreign Animal Disease Diagnostic Laboratory, Plum Island:

1) Maintain (and as appropriate update) current diagnostic capabilities,

2) Develop diagnostic capabilities which include reagents to identify both antigens and antibodies as appropriate for those exotic diseases which would cause undesirable economic consequences if introduced into the U.S., a list of which was published in the proceedings of an earlier USAHA meeting.

Resolution No. 12
Source: Committee on Zoological Animals
Subject Matter: Rinderpest Testing of Exotic Ruminants and Swine
Not approved by general assembly.

Resolution No. 13
Source: Committee on Animal Welfare
Subject Matter: Animal Health Planning and Steering Committee
Resolution

BE IT RESOLVED THAT USAHA again take a leadership role by establishing a planning and steering committee which will sponsor one or more symposia that can effectively address animal welfare, health, and regulatory concerns in a local regulatory context. This committee should include city, county, and state authorities who must increasingly assume the burden of good animal welfare, health, and regulatory standards in spite of decreasing resources.

Resolution No. 14
Source: Committee on Sheep and Goats
Subject Matter: Approved Test for Brucella ovis
Resolution

BE IT RESOLVED THAT the USAHA recommends approval by USDA of the ELISA test to identify B. ovis infected rams.

Resolution No. 15
Source: Committee on Sheep and Goats
Subject Matter: Nematodirus battus
Resolution

BE IT RESOLVED THAT the USAHA encourages the USDA to insure that the necessary epizootiological investigations for Nematodirus battus be conducted for developing control programs.
Resolution No. 16
Source: Committee on Sheep and Goats
Subject Matter: *Nematodirus battus*
Resolution
BE IT RESOLVED THAT the USAHA encourages priority funding and investigations for developing *Nematodirus battus* control programs.

Resolution No. 17
Source: Committee on Sheep and Goats
Subject Matter: *Nematodirus battus*
Resolution
BE IT RESOLVED THAT the USAHA encourage the USDA/APHIS/NVSL to continue surveillance programs to monitor the potential spread and increased population of *N. battus* in sheep.

Resolution No. 18
Source: Committee on Parasitic Diseases and Parasiticides
Subject Matter: Interdisciplinary Research Teams in Parasitology to Improve Livestock Health and Performance
Resolution
BE IT RESOLVED THAT the USAHA interact with USDA, the American Association of Veterinary Parasitologists (AAVP), the livestock associations, and the animal health industry to encourage interdisciplinary physiology, nutritional, immunology, and parasitology research teams to develop integrated parasite management methods for improved livestock health and production.

Resolution No. 19
Source: Committee on Foreign Animal Diseases
Subject Matter: Resolution to Amend Current Rinderpest Test Requirements for Imported Exotic Ruminants
Not approved by general assembly.

Resolution No. 20
Source: Committee on Parasitic Diseases and Parasiticides
Subject Matter: Horn Fly Resistance
Resolution
BE IT RESOLVED THAT the USAHA encourages accelerated research efforts into development of non-pyrethroid insecticides and evaluation of predictable resistance patterns so that rotational programs to control horn fly can be developed, and
BE IT RESOLVED THAT a practical resistance test kit be developed so that horn fly resistance can be evaluated on a regional basis.

Resolution No. 21
Source: Committee on Bluetongue and Bovine Leukosis
Subject Matter: Establishment of a Surveillance Program for Bluetongue virus Serotype 2

Resolution
BE IT RESOLVED THAT the USDA/APHIS along with participating states establish a bluetongue surveillance program to define the distribution, the vectors involved in transmission and the economic losses associated with infection.

Resolution No. 22
Source: Committee on Bluetongue and Bovine Leukosis
Subject Matter: Bluetongue Virus Vaccine Development

Resolution
BE IT RESOLVED THAT the research agencies in the USDA and the livestock industries support research and development of safe and efficacious bluetongue vaccines for use in ruminants.

Resolution No. 23
Source: Committee on Bluetongue and Bovine Leukosis
Subject Matter: Research on Improved Diagnostic Tests for Bluetongue Virus Detection

Resolution
BE IT RESOLVED THAT the USDA Research Agencies continue to support the development and application of improved diagnostic tests for the identification of bluetongue virus in infected animals.

Resolution No. 24
Source: Committee on Bluetongue and Bovine Leukosis
Subject Matter: Testing of Embryo Transfer Donor Cows for Bovine Leukosis

Resolution
BE IT RESOLVED THAT the USDA, APHIS recognize that testing of donor cows for bovine leukosis virus or bovine leukosis virus antibody is unnecessary to preclude transmission of the virus via embryo transfer and that USDA, APHIS encourage elimination of unnecessary testing requirements for bovine leukosis virus for import or export of bovine embryos.
Resolution No. 25
Source: Committee on Import-Export and Foreign Animal Diseases
Subject Matter: Embryo Disease Transfer
Resolution
BE IT RESOLVED THAT the USAHA strongly urges the USDA to properly design, fund, and conduct such field trials as necessary to determine the probability of disease transmission in the course of transferring a large number of embryos from infected livestock to susceptible recipients.

Resolution No. 26
Source: Committee on Import-Export
Subject Matter: Embryo Transfer Protocol Task Force
Resolution
BE IT RESOLVED THAT representatives of the Secretary of Agriculture be urged to meet prior to December 1, 1986, with a task force from the USAHA to establish protocol that will substantially accelerate the movement of embryos between the U.S. and countries abroad.

Resolution No. 27
Source: Committee on Foreign Animal Diseases
Subject Matter: Electronic Accessibility of Foreign Animal Disease Information
Resolution
BE IT RESOLVED THAT new applications need to be used to develop the electronic accessibility of FAD literature for a broad base of users and that new techniques such as problem-knowledge couplers, and interactive video-disc programs need to be applied to improve the training, awareness, and recognition of FAD.

Resolution No. 28
Source: Committee on Transmissible Diseases of Swine
Subject Matter: Diseases in Feral Swine and Control of Movements of Feral Swine
Resolution
BE IT RESOLVED THAT USAHA endorse the concept of the model state regulations for control of zoological animals and the inclusion of wild forms of domesticated species in that regulation.

Resolution No. 29
Source: Committee on Pharmaceuticals, Pesticides and Related Toxicology
Subject Matter: Cattle Growth Implants
Resolution

BE IT RESOLVED THAT the USAHA strongly urge the USDA, the Department of Trade and Congress to take whatever actions are necessary to discourage the European Economic Community from implementing the restriction or ban on importation of meat derived from animals treated with animal drug implants approved by the U.S. Food and Drug Administration, where the restriction or banning is not based on sound scientific data.

Resolution No. 30 and 37
Source: Committee on Tuberculosis (Subcommittee on Paratuberculosis)
Subject Matter: Increased Paratuberculosis Research

Resolution

BE IT RESOLVED THAT the Tuberculosis and Paratuberculosis Committee work to identify priorities for research and other programs aimed at prevention, diagnosis, control, and elimination of paratuberculosis, and

BE IT FURTHER RESOLVED THAT the USAHA work to encourage all levels of the animal health industry to secure funding for research on paratuberculosis at a level relative to its economic importance.

Resolution No. 31
Source: Committee on Brucellosis
Subject Matter: Federal Funding for Fee Basis Vaccination

Resolution

BE IT RESOLVED THAT the USAHA assembled in annual session at Louisville, Kentucky, emphasizes the need for continuation of calfhood vaccination as a primary tool for brucellosis eradication in high incidence states. The Association strongly urges restitution of funding to assure high levels of vaccination are continued. Those federal funds are not to be used to reimburse veterinarians for vaccinating calves at auction markets or concentration points just to qualify them for interstate movement.

Resolution No. 32
Source: Committee on Tuberculosis and Johne’s Disease
Subject Matter: Tuberculosis Guide Recommendations

Resolution

BE IT RESOLVED THAT the United States Animal Health Association recommends to the Secretary of Agriculture of the United States that he accept the revision of the Bovine Tuberculosis Projects Guide and that the suggested revisions by the USAHA be forwarded to the Pan American Health Organization with the recommendation that they institute in accordance with their policies a revision of the Guide for Bovine Tuberculosis Projects.
The United States Animal Health Association also recommends that the revised Guide recommendations be furnished to other international organizations and bilateral assistance governmental agencies that have an interest in Animal Health related projects.

The United States Animal Health Association further recommends that policies developed and implemented by USDA take into consideration the needs and goals of the Tuberculosis Programs in other American countries.

Resolution No. 33
Source: Committee on Professional Oversight
Subject Matter: Information Management and the BIS System
Resolution
BE IT RESOLVED THAT the USAHA is opposed to the 1986 BIS User Group Report’s recommendation to establish minimum acceptable levels of participation by a state in the Brucellosis Information System.

Resolution No. 34
Source: Committee on Professional Oversight
Subject Matter: Information Management and the BIS System
Resolution
BE IT RESOLVED THAT USAHA supports the recommendations of the BIS Users Group as they relate to the furthering of state/federal collaboration in the development and utilization of computer information systems for all cooperative programs within the animal health industry.

BE IT FURTHER RESOLVED THAT USAHA supports the movement of the current Brucellosis Information System based on a central main frame concept to a more distributed data processing environment encompassing data for all state/federal cooperative animal health programs and the use of microcomputers to support the programs and function as a primary record keeping system.

Resolution No. 35
Source: Committee on Biologics
Subject Matter: Approval of Official Diagnostic Tests
Resolution
BE IT RESOLVED THAT USAHA urge USDA-APHIS to confer with AAVLD for the purpose of updating and expediting procedures for approval of official tests.

Resolution No. 36
Source: Committee on Tuberculosis and Johne’s Disease
Subject Matter: Tuberculosis in Mexican Steers
Resolution

BE IT RESOLVED THAT the USAHA recommends the establishment of a group of tuberculosis experts from the USA and Mexico to include cattle industry representatives from each country for the purpose of:

a. Investigating international movements of livestock which might cause the spread of tuberculosis and providing specific recommendations concerning testing and identification.

b. Determining disease prevalence in the border states with recommendations for appropriate action, and

c. Making recommendations at least annually to their respective Departments of Agriculture at the Ministerial or Secretarial level and notifying all border states in both countries.

BE IT FURTHER RESOLVED THAT the USAHA resolution on M branding Mexican cattle on the jaw approved in 1985 be implemented by USDA.

Resolution No. 38
Source: Committee on Rabies
Subject Matter: Rabies danger posed by non-traditional animal species kept as household pets

Resolution

BE IT RESOLVED THAT the USAHA endorses the position of the American Veterinary Medical Association and the Rabies Compendium of the National Association of Public Health Veterinarians that these wild, exotic and non traditional animal species should not be maintained as household pets and should not be vaccinated against rabies by any of the currently licensed rabies vaccines.

Resolution No. 39
Source: Committee on Rabies
Subject Matter: Biopsy technique for diagnosis of rabies

Resolution

BE IT RESOLVED THAT the USAHA recognizes the current skin biopsy technique is of limited value in the management of animals suspected of being infected with rabies and should not be used to the exclusion of current diagnostic techniques using post mortem brain tissue as the basis for the definite diagnosis of rabies.
REPORT OF THE COMMITTEE ON ANAPLASMOSIS

Chairman: Dr. W. B. Fairchild, Baton Rouge, LA

Vice Chairman: Dr. K. L. Kuttler, Moscow, IN

Dr. J. L. Alley, AL; Dr. R. D. Anderson, NV; Dr. J. F. Badger, MO; Dr. D. M. Bedell, GA; Dr. G. M. Buening, MO; Dr. A. A. Cuthbertson, NV; Dr. C. A. Gipson, WI; Dr. R. L. Hartin, OK; Dr. T. J. Holt, PR; Dr. J. D. Huber, MD; Dr. E. W. Jones, MS; Mr. D. Kimbrell, AR; Dr. S. D. Lincoln, ID; Dr. D. G. Luther, LA; Mr. M. L. Main, SD; Dr. M. J. McDonald, KY; Dr. W. G. Nelson, ID; Mr. J. O. Pearce, Jr., FL; Dr. M. Ristic, IL; Dr. N. R. Swanson, WY.

Dr. Ralph Bram of USDA, ARS gave an overview of the decision reached by ARS to place all of its support in the area of Anaplasmosis research behind the development of monoclonal diagnostic test and subunit vaccines for future use in the study and/or control of anaplasmosis. He stated that a committee composed of anaplasmosis research workers, representatives of ARS, and Dr. James Glosser concluded that this approach would be best in developing procedures to be used in the study of the epidemiology and anaplasmosis, the diagnosis of anaplasmosis, and in the development of better vaccines for the control of anaplasmosis.

Dr. Charles Gibson of USDA, APHIS gave a report on the anaplasmosis research workers conference held in Baton Rouge, LA. He stated that progress was being made in the development of a subunit vaccine for anaplasmosis, but there was no consensus of opinion within that group as to when such a vaccine would be available for possible commercial production.

Dr. Y. L. Zaugg of USDA, ARS gave an update on anaplasmosis infection in non-domesticated animals of North America. He reported that with the exception of Anaplasma marginale infection of the black-tailed deer, no serious clinical infections have been observed in any North American wild ruminant host, although most are experimentally susceptible. As such, wild ruminants do not appear to pose a serious threat to livestock as reservoirs of anaplasmosis. He also reported that black-tail jackrabbits were a host for developmental stages of the vector tick Dermacentor andersoni and based on studies he conducted he found no evidence to support the hypothesis that jackrabbits have an important role in the transmission of anaplasmosis, nor would the species represent a suitable laboratory model.
The roles that non-domestic animals might play in the epizootiology of anaplasmosis, and their relative importance to livestock industries have been addressed frequently by this committee. Committee recommendations and/or USAHA resolutions specifically stressing the need to obtain better non-domestic *Anaplasma*/host information were recorded in the USAHA proceedings in 1956, 64, 66, 73, 74, 80, 84 and 85.

As a general background, while *Anaplasma marginale* is the primary pathogen in bovine anaplasmosis, it is not confined to cattle, nor is it the only pathogen of the genus. Soon after Theiler's description of *A. marginale* in 1910, he identified a second *Anaplasma* species, *A. centrale*, which produced a relatively mild pathogenic response in cattle. Its close antigenic similarity to *A. marginale* led to its widespread use as a pre-munizing vaccine to prevent clinical anaplasmosis.

Another important, but generally less pathogenic, species is *A. ovis*. Ovine anaplasmosis was described in 1912 from infections found in sheep and goats in Africa. The disease is common in Africa, Asia and the Middle East. It has also been found in Europe. The first naturally occurring infection in the Western Hemisphere was detected in 1955 in sheep originating from the western United States.

In addition to these well recognized anaplasms an *A. buffeli* was identified in Egyptian water buffalo; *A. masaeterum* was observed in sheep in the Netherlands; and an *A. equi* in European horses. There may be many unidentified anaplasms throughout the world.

The presence of *Anaplasma* bodies in erythrocytes of animal species other than cattle and sheep pose two possibilities: The organism seen may be antigenically distinct and specific for the species in which it is seen, or it may be one of the recognized anaplasma in a non-bovine or non-ovine host. Apart from concerns for the well being of the wild animals in question, the obvious importance of such findings to the livestock industry is whether or not these animals pose a threat as carriers or reservoirs of disease from which livestock might become infected. In the United States there are many areas where domestic and wild animals intermingle.

In 1984 Dr. Kenneth Kuttler published a review of infections of *Anaplasma* in which were effectively summarized the history and then current knowledge of wild and domestic hosts of species of *Anaplasma* and the associated epizootiology.

*Anaplasma* infections in white-tailed deer (WTD), *Odocoileus virgin-
ANAPLASMA INFECTIONS

ianus, have been studied extensively by numerous workers. These deer are readily infected with both A. marginale and A. ovis. Even though clinical signs of infection are minimal, WTD may retain a carrier infection for years. Efforts to isolate Anaplasma from 270 WTD in SE U.S., an endemic zone, were totally negative. Only 7 of 616 WTD from Missouri were seropositive. These results, together with similar observations, support the view that WTD do not represent a reservoir of infection of any importance. Further, it was WTD that Dr. Kuttler used in passages of A. marginale to obtain the attenuated vaccine he reported on last year in this meeting.

Mule deer (MD), Odocoileus hemionus hemionus, have been studied less extensively than WTD, but isolations of Anaplasma have been made from MD in Idaho and Wyoming. However, similar efforts in Oregon were unsuccessful.

We induced an experimental A. marginale infection in MD. A splenectomized fawn was inoculated with a stabilate made from the WTD A. marginale material Dr. Kuttler obtained. Fourteen days after inoculation a parasitemia was detected and sera elicited positive reactions on the RCA and CF tests. The deer showed no clinical signs of illness. The Anaplasma pathogen was passed to splenectomized calves via deer blood inoculations on day 36 post exposure. The carrier state was confirmed 261 days after the original inoculation by recovery in a splenectomized calf. Also on day 261, 5 ml of whole MD blood was inoculated into a mature, spleen-intact steer. Twenty-five days later the steer began a very mild, transient infection (max. PPE:2.1, low PCV: 34-, average norm: 38). Solid protection was established against virulent A. marginale challenge.

Therefore, it is unlikely that the presence of A. marginale in MD represents a disease threat to this species or provides a significant non-bovine reservoir of infection for cattle.

Two MD, one splenectomized and one spleen-intact, were inoculated with 10 ml each of pooled whole blood from known A. ovis carrier ewes. The ewes had been experimentally infected some months before by inoculation with whole blood from a naturally infected carrier ewe from SW Idaho. Parasitemias and seropositive responses were detected 47 and 60 days after inoculation in the splenectomized and intact deer respectively. The intact deer exhibited no clinical signs of disease. The max. PPE was only 0.6% and its PCV value only decreased 11% below normal. Even though the splenectomized deer developed a parasitemia of 36.0% and its PCV value decreased over 50% (19) no clinical signs of illness were evident. Blood from both deer proved to be infective to splenectomized sheep via subinoculations on day 60 post exposure (PPP 15 and 20 days).

On the other hand, black-tailed deer (BTD), Odocoileus hemionus columbianus, have been shown to be reservoirs of A. marginale infection for cattle in California. This wildlife reservoir of infection has significant
implications in that it effectively negates control of anaplasmosis by the conventional methods of test, segregation and treatment. Of the 3 species of deer in the U.S., the BTD appears to be the most susceptible to *A. marginale*. I know of no studies done to evaluate its susceptibility to *A. ovis*. The BTD are narrowly distributed in a strip along the Pacific coast from Monterey, California north through Oregon and Washington to central British Columbia. To my knowledge, however, anaplasmosis has not been a problem west of the Cascades in Oregon or Washington.

Peterson and Roby (1975) failed to detect evidence of anaplasmosis in bison using serology and blood inoculation into splenectomized calves, even though the bison were located in an anaplasmosis endemic area of eastern Oregon. For the past 4 years we have been fortunate enough to be invited to obtain blood samples from bison at the National Bison Range in Moise, Montana. Of about 620 adult animals sampled only 13 have been identified as serologically positive on both RCA and CF tests. To date, none of the National Bison Range blood samples have proven infective to splenectomized cattle or sheep.

We did find, however, that bison experimentally infected with *A. marginale* were susceptible to the disease and responded to the infection within the same time frame as do cattle. Both splenectomized and spleen-intact bison were infected. The intact bison exhibited no obvious clinical signs of illness, and despite a low PCV value of 8%, the splenectomized bison showed only mild signs of depression. Blood from both animals transmitted disease to splenectomized cattle. The carrier state of both bison was demonstrated by blood inoculations 314 and 496 days after original experimental *A. marginale* infection.

In a similar study, a splenectomized bison remained clinically, hematologically and serologically normal for over 300 days after repeated inoculation with ovine blood infected with *A. ovis*. This suggests that bison, like cattle, are susceptible to *A. marginale* but apparently refractory to infection with *A. ovis*.

Pronghorn antelope (*Antilocapra americana*), elk (*Cervus elaphus*) and bighorn sheep (*Ovis canadensis*) have been experimentally infected with *A. marginale*, which in turn was recovered in cattle. These animals may represent potential reservoirs of infection, but most efforts to recover *Anaplasma* from wild populations have been unsuccessful.

There is some presumptive evidence that elk may harbour *A. ovis* or a closely related anaplasma. Sheep inoculated with elk blood became positive to the CF test but developed no detectable parasitemia. Challenge of these sheep with *A. ovis* failed to produce apparent parasitemia, suggesting that an *A. ovis* infection had occurred in sheep after the elk blood inoculation.

We found pronghorns to be susceptible to experimental *A. ovis* infections. Three spleen-intact pronghorn fawns were inoculated with *A. ovis*-infected carrier ewe blood. Susceptible sheep received the same inocu-
lum at the same time. Although the prepatent period of 40 days observed with the pronghorns was twice that of 21 days in intact sheep, the course of the infections was essentially the same in both host species. No clinical signs of illness were observed in the pronghorns. The A. ovis agent was recovered again via subinoculation of pronghorn blood into susceptible sheep.

For many years several investigators have speculated about the existence and importance of non-ruminant, small mammal reservoir hosts of A. marginale. Jackrabbits have received the most attention because they often host the immature stages of the vector tick, Dermacentor andersoni, and they occupy the same geographical areas as the range considered at greatest risk of anaplasmosis exposure. Cesarean delivered black-tailed jackrabbits (Lepus californicus), splenectomized and spleen-intact, were repeatedly inoculated with blood from acutely infected cattle. None of the hares developed any signs (clinical, hematologic or serologic) of anaplasmosis for over 10 months. Blood from the jackrabbits failed to produce infection in splenectomized calves. Also, blood from wild-collected jackrabbits, obtained from known anaplasmosis endemic areas, failed to produce disease when inoculated into splenectomized calves. Based on these results, there is no evidence to support the hypothesis that jackrabbits have an important role in the epizootiology of anaplasmosis in SW Idaho, nor that this species might represent a suitable laboratory model.

In summary, with the exception of A. marginale infections in BTD, no serious clinical infections have been observed in any North American wild ruminant host, although most are experimentally susceptible. As such except for the BTD in California, wild ruminants do not appear to pose a serious threat to livestock as reservoirs of Anaplasma.
DEVELOPMENT OF A RECOMBINANT VACCINE AGAINST BOVINE ANAPLASMOSIS
Travis C. McGuire, Anthony F. Barbet, Guy Palmer and Peter Myler
University of Florida
Gainesville, Florida 32610

ABSTRACT
We have identified and isolated a surface protein of 105,000 molecular weight from Anaplasma marginale (Am 105). Monoclonal antibodies to this protein neutralize infectivity of the organism and the purified protein immunizes calves against challenge with A. marginale (Science 1986 231, 1299). Although the protein can be purified from infected cattle erythrocytes, the yield is low and the technique cumbersome and time-consuming; we have therefore employed recombinant DNA methods to provide a more convenient source of Am 105. A. marginale DNA was isolated from infected erythrocytes and genomic libraries prepared in E. coli. These libraries were screened for expression of Am 105 antigenic determinants by in situ antibody screening on nitrocellulose filters. We have discovered that native Am 105 consists of a complex containing two antigenically unrelated polypeptides of similar molecular weight: Am 105L and Am 105U. We initially identified recombinant bacteria that expressed the complete neutralizing monoclonal antibodies. Subsequently, we identified recombinant bacteria that expressed part of the Am 105U gene, cloned into a Puc 9 plasmid expression vector. The expressed recombinant protein was 55,000 molecular weight and was immunoprecipitated by neutralizing monoclonal antibodies to A. marginale. This recombinant protein is, therefore, a potential protective immunogen for cattle. The recombinant polypeptide was purified from bacteria by monoclonal antibody affinity chromatography and is being tested for protection in immunization and challenge experiments.
REPORT OF THE COMMITTEE ON ANIMAL WELFARE

Chairman: Mr. E. M. Stewart, Lincoln, NE
Vice Chairman: Mr. R. Gadd, Ft. Pierre, SD

Dr. L. G. Billingsley, CA; Mr. N. Black, MN; Dr. B. H. Ewald, NJ; Ms. A. Gonnerman, MO; Dr. C. H. Graham, MO; Mr. T. M. Gustafson, NE; Mr. F. E. Hasanauer, CA; Ms. B. Heffernan, DC; Mr. R. D. Jones, SD; Mr. D. L. Jones, KS; Dr. R. J. Lee, VA; Mr. M. L. Main, SD; Dr. M. J. McDonald, KY; Dr. D. Meeker, IA; Dr. W. D. Miller, VA; Dr. R. B. Moody, MO; Dr. R. L. Morter, IN; Ms. M. A. Owen, MA; Mrs. R. Polen, NJ; Dr. D. A. Price, CO; Dr. R. A. Rice, FL; Dr. R. L. Rissler, MD; Mr. G. W. Roberts, CA; Dr. J. D. Roswurm, CA; Mr. J. Schmidt, KS; Dr. M. S. Silberman, GA; Mrs. C. Stevens, DC; Dr. W. C. Stewart, MD; Dr. R. M. Wainwright, NY; Dr. N. E. Wiswall, MD.

The Animal Welfare Committee met at 1:30 p.m., October 21, 1986, in the King Room of the Executive West Hotel, Louisville, Kentucky, Vice Chairman Mr. Robert Gadd presided. Forty-five people attended the meeting including nineteen committee members.

Chairman Gadd opened the meeting with introduction of the committee members and a call for copies of proposed resolutions. The minutes of the last meeting were approved as distributed.

Dr. William Stewart, Senior Staff Veterinarian, Animal Welfare, Veterinary Services, presented an update report on Veterinary Services' accomplishments in Animal Welfare during the past year. He also presented a review of the amendment to the Animal Welfare Law enacted to take effect on January 1, 1986, and the progress that has been made toward implementation of those changes.

A panel discussion followed on the subject of "Condition of Animal Care and Regulation in the U.S." The panel members were Dr. David Bromwell, Chief Veterinarian, Bureau of Animal Health, Illinois Department of Agriculture; Ms. Ann Gonnerman, National Society for the Protection of Animals; Dr. Nancy Wiswall, Area Veterinarian in Charge, Veterinary Services, Maryland, Delaware, and the District of Columbia; and Mr. Roy Carlbert, Executive Secretary of the American Kennel Club.

Dr. Wiswall spoke on the role of Veterinarians in Charge in Animal Welfare, the progress that has been made and work that lies ahead in continuing to raise the consciousness of everyone toward concerned care for animals. Dr. Bromwell stressed the great amount of money being spent each year by local communities on animal control. He suggested that breeders of dogs and cats be taxed to help support the cost of dealing with unwanted animals. Ms. Gonnerman spoke on the need for further symposiums on the problem of overpopulation of pet animals and the need to have further dialog with and among organizations responsible for local animal control. She outlined how various national organizations are failing to
cope with this problem. Mr. Carlberg explained the American Kennel Club's (AKC) role as a registry of purebred dogs and their enforcement efforts and limitations. He also explained AKC’s willingness to assist with records on individual breeder violations of the law when such records on individuals are properly subpoenaed. A short discussion followed.

There was no old business.

New business began with a presentation by Peter K. Swiderck, SCWDS, University of Georgia, College of Veterinary Medicine, on his and Dr. Victor Nettles efforts to formulate a Model State Regulation for Control of Zoological Animals.

Committee members who wished were asked to review the model in detail during the next three months and submit comments.

During the discussion Barbara Heffernan suggested that the term “zoological animal” be changed to avoid the connotation that approved zoos and parks were involved in the problems of exotic animal auctions and dissemination of exotic animals. Ms. Christine Stephens asked that movement of pet birds be restricted to captive bred birds. Barbara Heffernan proposed an expression of appreciation to the group.

A resolution was presented to the group from Dr. Wiswall to establish a USAHA planning and steering committee for the purpose of establishing one or more symposiums to address animal welfare, health and regulatory concerns in a local regulatory context.

After considerable discussion and some wording changes, the committee voted to accept the resolution.

Ms. Christine Stephens submitted the following statement to be added to these minutes: The Animal Welfare Committee of the USAHA expresses appreciation of the increasing effective administration of the Animal Welfare Act by USDA's Veterinary Services and encourages this agency in its important new responsibilities under the Improved Standards for Laboratory Animal Amendments.

The meeting adjourned at approximately 4:45 p.m.
REPORT OF THE COMMITTEE ON BIOTECHNOLOGY

Chairman: Dr. F. J. Mulhern, Washington, DC
Vice Chairman: Dr. A. Strating, Fort Worth, TX

Dr. D. C. Alexander, Canada; Dr. C. W. Beard, GA; Dr. C. L. Campbell, FL; Dr. E. A. Carbrey, IA; Dr. J. A. Cobb, GA; Dr. R. A. Crandell, TX; Dr. J. J. England, LA; Dr. D. A. Espeseth, MD; Dr. K. R. Hook, IA; Dr. J. P. Kluge, IA; Dr. J. R. Ragan, TN; Dr. J. A. Schmitz, NE; Dr. S. T. Wilson, Jr., MD.

Due to the controversy surrounding developments and rapid changes that are taking place in the field of biotechnology, the leadership of USAHA established this year a new committee on biotechnology. Judging from the standing room only attendance at our meeting, there is considerable interest in this subject matter by members of this association.

Three speakers gave descriptions of selected high technology diagnostic, therapeutic or prophylactic products which are now available or in various stages of development. Three others described to the audience the governmental organizational structure and mechanisms for regulation and control of biotechnology. USDA is heavily involved at a variety of levels as are FDA, EPA, and others.

The scope of the effort to develop new and improved techniques and products through biotechnology was described. Worldwide, the effort is huge, involving an estimated 450 commercial companies, 85% of which are small biotechnology companies and 2/3 of which are less than ten years old. In the relatively few years since biotechnology effects were begun, a significant number of products are already available, especially in the human health area, and a large number are under development.

The Food and Agriculture Organization of the United Nations recently held a meeting in Rome, Italy, to place emphasis on developments in this area urging countries to meet the needs of these so-called exploding events. They stressed their concern that new products in the areas of nutrition, animal production and breeding, growth hormones, penside diagnostic tests, monoclonal antibodies and vaccines using vectors of animal pathogens will bring new challenges that must be met by technical and scientific groups, as well as the government regulating bodies.

The United States has the lead in these developments in veterinary biotechnology. There are 92 firms currently engaged in these activities. Most firms are new, and one-third are a mixture of traditional firms ranging from small pharmaceutical houses to large conglomerates. A total of 171 separate veterinary biotechnology products have been identified as being currently underway in industry. Leading product areas include vaccines, growth hormones, and a wide assortment of probes and vectors to diagnose and treat animal disease.

Experts predicted the emergence of 212 distinct veterinary products and
REPORT OF THE COMMITTEE

processes made possible by biotechnology breakthroughs. Two-thirds of these 212 advances will be technology feasible to produce within the next year and a half and commercially available between two and a half to five years from January of 1986.

Many recent articles in the popular and technical press have mentioned the multi-million dollar investments made by many large firms which is evidence of the research by them for the potential markets in this area. We are all going to be affected by this movement in our societies, and the USAHA needs to stay abreast and plan to meet these changes.

It is clear that biotechnology has and will provide a means of giving us in many cases much improved products and tests as compared to conventional technology. Antigens provided through recombinant technology are often much more thoroughly characterized, thus providing for potentially more predictable efficacy and consistent safety. Concerns for containment and control of these products, whether well founded or not, must however be aggressively met.

New high technology diagnostic kits are already available for a variety of animal and poultry diseases. It is stressed that the new kits must, before they are approved, be carefully compared to standard methods and have clearly demonstrated sensitivity, specificity and reproducibility. Conventional serological and microbiological technology must not be abandoned even after the new methods are proven so that continuing assurance of their value is provided.

A special challenge in the use of diagnostic kits relates to the control of their use in the field. Many tests are easily conducted and amenable to use by practicing veterinarians, farmers and ranchers. Except for those diseases which have official control programs in place or anticipated, it is assumed that relatively little control can be placed on the distribution and use of kits. The Biotechnology Committee urges that each standing USAHA committee that deals with diseases for which official control programs are anticipated aggressively address the issues related to the unrestricted use of field kits. State veterinarians are urged to carefully assess the impact of the possible widespread use of diagnostic kits in their individual states.

The traditional role of the general purpose veterinary diagnostic laboratory will to varying degrees be affected by the use of field kits. While demands for first line diagnostic support by them may decrease, their role in supplying reference data and backup support for complex or highly sensitive cases may well increase significantly.

A detailed scheme for USDA assessment and approval of veterinary biological products was reviewed by the Committee. The process, though long and appearing to be cumbersome, is composed of essential elements that cannot be shortcut. The Department’s responsibility in assuring uses of safety, potency and efficacy are obvious, and in certain respects, the
BIOTECHNOLOGY

approval process closely resembles that used for conventional products. It is also clear that these new technological advances are going to require personnel that are fully qualified on the newer techniques in order to provide proper analysis before products are approved.

A recently highly publicized legal challenge of the USDA licensing of a gene deleted pseudorabies vaccine was reviewed by the Committee. It is important to note that the challenge was based on a procedural issue and not on the safety of the product. In the case of products produced through biotechnology, both real and perceived concerns for environmental safety must be addressed and satisfied.

The Committee recognized that the APHIS Veterinary Services Biologics Staff has been faced with applications from a large number of relatively new biotechnology companies, as well as companies that have recently been added through the expanded scope of the amended Virus Serum Toxin Act. It is also recognized that very significant progress has recently been made in streamlining the government process for biotechnology.

State and Federal animal health officials are urged to make every effort to inform their constituents regarding biotechnology in order to prevent unwarranted concerns, as well as unwarranted expectations, for these newly available products and tests. Regulatory officials can thus establish an early role on their part in the use and application of this new technology.

Many of these new concepts have been considered by the various committees of USAHA for the past ten years. This Committee would like to sensitize the chairmen and members of the other committees to keep us informed of any such issues that develop in your deliberations that may relate to our responsibilities in USAHA. The Committee also urges that members of the association who are actively engaged in these new developments in biotechnology apply for membership on this Committee.

In the present times, we are often caught between so-called “catch 22 situations.” In the case of biotechnology advances, we see the potential for tremendous improvements to overcome some of our more pressing problems. Thus, we are eager to speed up the process to obtain them. Better judgment tells us to be sure that whatever is produced and used must be safe and efficacious. This often delays progress and may even hinder or prevent the development of worthwhile products due to time and costs. Hopefully we have learned from the past and will derive safe and efficacious products in biotechnology in the shortest times possible so that our society can receive the benefits from them. That is the real challenge facing the regulatory authorities.
REPORT OF THE COMMITTEE ON INFECTIOUS DISEASES OF CATTLE

Chairman: Dr. V. A. Seaton, Ames, IA
Vice Chairman: Dr. L. M. Siegfried, Madison, WI

Dr. W. F. Alexander, OK; Dr. A. A. Anderson, IA; Dr. R. P. Azelton, MO; Dr. D. E. Bartlett, WI; Dr. H. Joe Bearden, MS; Dr. R. E. Bohlender, NE; Dr. E. A. Carbrey, IA; Dr. C. S. Card, AZ; Mr. R. W. Cellon, Jr., FL; Dr. R. A. Crandell, TX; Dr. G. L. Crenshaw, CA; Dr. D. P. Ferlicka, MT; Dr. A. M. Gallina, WA; Dr. G. D. Gurss, KS; Dr. L. R. Harrison, GA; Dr. G. Lambert, IA; Dr. A. J. Luedke, CO; Dr. C. S. McCain, OK; Dr. C. A. Mebus, NY; Dr. J. M. Miller, IA; Dr. P. A. O'Berry, IA; Dr. B. I. Osburn, CA; Dr. D. H. Schlafer, NY; Dr. J. A. Schmitz, ME; Dr. R. D. Schultz, WI; Dr. W. L. Sippel, FL; Mr. R. Smith, KS; Dr. D. E. Suther, CA; Dr. N. R. Swanson, WY; Dr. M. J. Van Der Maaten, IA; Dr. K. D. Weide, MO.

The Infectious Diseases of Cattle Committee met at 1:20 PM on October 21, 1986 in the Heather Room of the Executive West Hotel, Louisville, KY, with twelve committee members and 23 visitors in attendance.

The reports presented to the committee are summarized as follows:

THE HISTORY AND CURRENT STATUS OF THE WISCONSIN JOHNE'S DISEASE PROGRAM

Dr. Joan Arnoldi
Wisconsin Department of Agriculture
Trade and Consumer Protection
Madison, WI

The first interest in the prevalence of Johne's disease in Wisconsin cattle occurred in the early '60s, with a small herd test and control program developing in 1968. By 1979, a vaccine was provided by the National Animal Disease Laboratory, Ames, Iowa for the use in herds in the Wisconsin Department of Agriculture's Johne's program. By 1982, program herds had expanded, a commercial vaccine was available, and 418 Wisconsin veterinarians were trained and licensed to administer the vaccine.

In 1984, a Johne's eradication program was implemented with guidelines for management and classification of program herds into one of 4 groups: documented free herd, program herd, identified herd and herd status unknown.

After two years, 450 Wisconsin herds were on the program, most of which were receiving the vaccine, and there were 14 documented free herds. Four of these herds eventually reverted back to Johne's positive status.

In 1985, a controlled survey of Wisconsin cattle for positive organisms on
culture revealed a prevalence rate of 7.8%. Comparison of these results to those of other states shows that Wisconsin's prevalence rate is not unusually high.

BOVINE LISTERIOSIS IN THE UNITED STATES

Dr. George Lambert
National Animal Disease Center, USDA, ARS
Ames, Iowa

The incidence of bovine listeriosis in the United States is unknown. However, the disease has been reported sporadically from all sections of the country. The bacteria *Listeria monocytogenes* is considered to be ubiquitous and most infections are subclinical. The clinical disease characterized by meningoencephalitis, abortion or septicemia is frequently fatal. Individual animals and humans immunocompromised by age, pregnancy, immunosuppressive drugs or concurrent debilitating nutritional, parasitic or infectious diseases are affected most frequently. Recently human infections in the United States have resulted from consuming pasteurized milk, Mexican style cheese and other dairy products. This has led to a reexamination of whether *L. monocytogenes* can survive pasteurization and the postpasteurization conditions which favor the growth and multiplication of the organism. Although selective culture media have been developed for the isolation of the organism from raw or pasteurized milk, many problems still exist. Some problems are related to the low level of shedding of *Listeria* in the milk, and to the intermittent shedding of the organism. This is further complicated by the comparatively large number of other bacteria, particularly nonpathogenic *Listeria* and other species that do survive pasteurization. Current research is devoted to developing rapid diagnostic tests and to determine the thermostability of various strains of *L. monocytogenes* and under what conditions they may survive the pasteurization process.

THE USE OF RESTRICTION ENDONUCLEASE ANALYSIS TO DIFFERENTIATE INFECTIOUS BOVINE RHINOTRACHEITIS VIRUS (IBRV) STRAINS

Dr. C. A. Whetstone
National Animal Disease Center, USDA, ARS
Ames, Iowa

Although modified-live (ML) infectious bovine rhinotracheitis virus (IBRV) vaccines are widely used, their implication in the occurrence of IBR after vaccination remains in question since laboratory techniques used to date have not been sensitive enough to differentiate vaccinal virus from field strain isolates. Molecular epidemiological studies of herpesvirus genomes from many species have shown that restriction endonuclease analysis (REA) is a useful technique for differentiating between viral
REPORT OF THE COMMITTEE

strains. Recently, we used this technique to characterize DNA from each of the ML IBRV vaccines licensed in the United States. (Whetstone, CA, Wheeler, JG, Reed, DE. Investigation of possible vaccine induced epizootics of infectious bovine rhinotracheitis, using restriction endonuclease analysis of viral DNA. *Amer J Vet Res* 1986;47:1789–1795). We also examined the DNA of IBRV isolates from 6 field epizootics where IBR was thought to be vaccine associated. In instances where virus was isolated from nasal swabs 9 to 10 days after intranasal (IN) vaccination with ML IBRV, or where virus was isolated from aborted fetuses 22 to 26 days after intramuscular vaccination (IM) with ML IBRV, the REA pattern of the virus isolated from the cattle was indistinguishable from that of the vaccinal virus. In another case, where IN vaccine was given to pregnant cows and IM vaccine was given to open cows, DNA from 2 IBRV isolates from aborted fetuses had REA patterns identical to the IM vaccine and 2 isolates were slightly different. In the rest of the cases, the REA patterns were different from those of the vaccinal virus.

Several questions arise from these results. (1) Will the REA pattern established for a vaccine remain constant with time? With USDA regulations governing the manufacturing of IBRV vaccines, there would be little chance of change in the REA pattern. (2) Are there IBRV field virus isolates that have the same REA patterns as vaccine strains? Further studies of isolates from field cases of IBR not associated with vaccination need to be done to confirm the uniqueness of the vaccine fingerprints. (3) Will the REA patterns of vaccinal virus change during animal passage? We are presently addressing this question in our laboratory. Preliminary results from samples recovered after primary IBRV inoculation with field isolates indicate that the REA pattern may change during primary infection, and that the changes may depend upon which tissue was the source of the virus. Patterns will also be studied in virus recrudesced from latent infections in these animals and in animals reinoculated with different IBRV strains. (4) When field isolate REA patterns are different from those of the vaccine, what is a significant difference? Regions of the IBRV genome that relate to virulence have not yet been identified. We hope to start addressing this question by mapping genomic changes in isolates we obtain from the experiments described above.

**A SURVEY OF WISCONSIN CATTLE FOR CHLAMYDIA PSITTACI ANTIBODY USING THE ENZYME-LINKED IMMUNOSORBENT ASSAY (ELISA)**

Dr. Lynne Siegfried
Wisconsin Animal Health Labs.
Madison, Wisconsin

*Chlamydia psittaci* is of interest in certain areas of the midwest because of the publicity associated with a putative “Atypical Chlamydia Syndrome” characterized by lameness, infertility and generalized debility and
This study was conducted to develop an ELISA to detect *C. psittaci* antibody in bovine serum, to establish a suspect range and positive threshold for the assay and to use the method to determine the prevalence and geographic distribution of *C. psittaci* infection in Wisconsin. A survey of 2,287 mature cows for *C. psittaci* antibody using the ELISA resulted in 4.2% positive and 10.5 suspect animals. All geographic sectors of Wisconsin had a low prevalence of detectable reactors. This *C. psittaci* antibody ELISA will be used to compare Wisconsin dairy herds apparently negative for Chlamydioidosis, with herds from which *C. psittaci* has been isolated and with herds containing cattle with the putative "atypical chlamydial syndrome."

*RESOLUTION*

The Subcommittee on Artificial Insemination presented a resolution concerning replacement of the adopted requirements for antibiotic treatment of bovine semen by pertinent states (effective January 1, 1988), to concur with Certified Semen Services (NAAB) requirements, effective January 1, 1988. This resolution was approved by the Executive Committee.

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Dr. A. Mebus and Dr. G. Callis, Plum Island Foreign Animal Disease Center, presented a progress report on a research program to test whether foot and mouth disease and bluetongue viruses can be transmitted from infected dams to embryos being frozen for importation into the U.S. and through these embryos into cattle within which transplantation occurs. The committee adjourned at 3:20 p.m. October 21, 1986.
The meeting convened at 1:30 p.m. Tuesday, October 21, 1986. Nine members and seventeen non-members attended.

The meeting opened with a discussion of the circumstances that led to FDA’s discovery of the recent heptachlor/treated seed problem in the tri-state area of Arkansas, Missouri and Oklahoma. As follow-up to an investigation of aflatoxin contaminated corn used for ethanol production, and the spent mash utilized as animal feed, the FDA discovered pink colored grains, indicative of pesticide treated seeds, in the mash sold as dairy feed. Analytical findings of heptachlor and other pesticides confirmed the misuse of pesticide treated seeds for feed.

As part of an Inter-Agency task force — FDA, USDA, and EPA — FDA conducted a survey to characterize the seed/feed problem. While the report showed that treated seed intended for planting is regulated by the Federal Seed Act (FSA), enforced by Agricultural Marketing Service (AMS), USDA, and is protected from diversion to other uses through labeling which prohibits use as food, feed or for oil purposes, once the seed is no longer intended for planting because of overproduction, loss of germination, etc., the FSA can no longer be enforced. EPA estimates that $60 million worth of chemicals is used annually for seed treatment and 8.2 billion pounds of seeds are treated annually. AMS estimates a 20–30% overproduction of treated seed yearly with about 50% of that carried over for future planting. While treated seed is expensive and salvage for animal feed is not usually a viable option unless there is no other use for the seed, there is about 1 billion pounds of seed to be disposed of yearly.

FDA surveyed over 1,000 seed treaters, brokers, feeders and all gasohol production plants. All of the latter disposed of their spent mash in landfills. Of the more than 100 firms selling treated seeds for animal feed, these were mostly in the mid-west, some in the south. The survey discovered that the majority of these firms were roasting the treated seeds with the intention to reduce the levels of pesticides and that detreatment by roasting was applied to seed grains other than corn and for pesticides other than captan.
Dr. Kennedy discussed the food additive regulation which permits detreatment of captan treated corn seed, to reduce the pesticide levels to 100 ppm or below, for use as livestock feed for beef cattle and swine, with the proviso to withhold such feed 14 days prior to slaughter, and described the role of the petitioner for that regulation, the American Seed Trade Association (ASTA), responsible for recordkeeping of sales of treated seed for detreatment.

John Adams, of the National Milk Producers Association, gave an overview of the problem as viewed from the milk producers. His position is that contamination was no fault of the milk producers and that indemnity for losses was justified — it proved cheaper to destroy animals than to feed them out. He recommended revocation of the regulation allowing for detreatment of seed corn identifying confusion as to the effectiveness of detreatment for all pesticides as the cause of the problem.

Mr. Herb Harrison, Office of Pesticides, EPA, discussed the revocation of heptachlor for all but termiticide use, and the provision to allow the then existing stockpiles to be used up. Recent surveys show some 66,000 gallons of end use product still on hand and it is estimated that this is a 10 year supply for pesticide treatment of seed. Mr. Harrison also discussed EPA's call-in for additional data on captan, its metabolites and tissue residues.

Dr. L. V. Daniels of the Department of Animal Science, University of Arkansas, discussed their findings on half life and depletion data on heptachlor and their efforts to decontaminate body fats through the use of mineral oil and butylated hydroxyanisol (BHA). While Arkansas had some limited success with mineral oil these data were not consistent with Missouri findings reported from the audience by Dr. Murl Raisbeck.

Dr. P. A. Stehr-Green, from the Center for Disease Control (CDC) discussed the heptachlor incident and its effect on human health. CDC identified 13 farms who drank their own raw milk and screened this high risk group for acute and long term effects. While they found a moderate increase in the body burdens of metabolites, the live function tests were normal and there was no clinical evidence of a problem. They are continuing to monitor the farm families at 3 month intervals to determine if the increase pesticide body burden is due to environmental exposure from pesticide use elsewhere. In addition, CDC checked urine samples from the high risk group for aflatoxin. While one was well above background levels, CDC concluded that aflatoxin was not of public health concern from this incident.

To present the perspective of the actual dairy farmers involved in the heptachlor contamination, Dr. Kennedy read a letter from Mr. and Mrs. Leonard O'Neil representing the dairy farmers of McDonald County, Missouri. That letter is submitted for review. Their frustrations in dealing with conflicting state and federal regulations were echoed from the floor. One member indicated that the influx of TV crews and federal representa-
REPORT OF THE COMMITTEE

tives drastically interfered with Missouri's ability to control the problem in their state.

Following a brainstorming session focused on solutions to the problems of existing heptachlor supplies and a risk benefits assessment of the captan detreatment regulation, the meeting adjourned at 5 p.m.

August 9, 1986

Ms. Annie Johnson
Food Safety & Inspection Service
USDA
South Administration Building
Room 3803
14th and Independence Ave., S.W.
Washington, D.C. 20250

Re: Statement on Heptachlor Contamination from McDonald County, Missouri Dairy Farmers — Docket #86-02N

Dear Ms. Johnson:

This letter is in response to the July 10, 1986, informational meeting at USDA with officials of FDA, USDA, and EPA regarding the recent heptachlor contamination in the Midwestern United States. At the end of this meeting, all who had not been previously invited to submit a statement for the record were invited to submit one within thirty (30) days to the above docket number.

As a Missouri dairy farmer from McDonald County, Missouri, I am submitting this statement for the record on behalf of myself and several other similarly affected farmers whose dairy cattle were quarantined after pesticide residues were found in our dairy milk product. These pesticides were traced back to the spent distillers grain that was sold as animal feed from Valet Feeds, Inc., in Van Buren, Arkansas.

On January 27, 1986, the Arkansas State Plant Board, Division of Feeds, Fertilizers & Pesticides took samples of feed from Emilita Bros. Farm, Ozark, Arkansas. The feed sample was “By Pass Protein Distillers Grain #2615” from Valet Feeds, Inc., Van Buren, Arkansas. This sample was taken on January 27, 1986, and report of the analysis was issued on February 3, 1986. In the analysis report it was indicated that no pesticide residues were found in the sample #2615. Also, “Pesticides not found in the present levels of detectability:

1. Terrezola (.1ppm)
2. Pen B (.3ppm)
3. Methoxychlor (10ppm)
4. Captan (.1ppm)
5. Aldrin (.1ppm)

(Report Attached as Exhibit #4).
ENVIRONMENTAL RESIDUES

In another report from the Arkansas Livestock & Poultry Commission, dated January 30, 1986, of the same feed sample #2615 from Valet Feeds, Inc., it is indicated that the test for Aflatoxin was negative. (Report Attached as Exhibit #5).

On January 29, 1986, samples of feed and milk were taken from our dairy farms for testing. These test results were not received until after February 25, 1986. However, our reliance upon representations made from the tests results of the Arkansas State Plant Board and the Arkansas Livestock & Poultry Commission reports induced us to continue purchasing additional tons of the feed from Valet Feeds to our detriment. When the test results from samples of feed and milk taken from our dairy farms became available, they indicated positive levels of various pesticide and chemical residues as follows:

1. Trans-chlordane
2. Methoxychlor
3. Heptachlor
4. Aflatoxin B1 and B2

It should be noted that, whereas the duration of time required to produce laboratory analysis on feed samples by the Arkansas Plant Board was six (6) days, the U.S. Department of Health, Food & Drug Administration, New Orleans, Louisiana, took twenty-six (26) days, between January 26, 1986 through February 25, 1986 to perform an analysis on feed samples. (Report Attached as Exhibit #5, and 6).

Moreover, the two different analyses produced totally different results. The Arkansas one produced no detectable levels of pesticides and other residues, whereas, one performed under the FDA indicated pesticide residues in highly detectable levels, including heptachlor, as well as other chemical residues. (Report Attached as Exhibit #6).

We are extremely concerned by the fact that the state and federal analyses produced totally different results on the samples of grain from Valet Feeds taken on the same day, January 30, 1986. From the fact that the two analyses differed, one moment we were told this feed was in compliance and could be purchased for our herds, of which we then purchased several additional tons, and the next moment we were quarantined for having used it and were required to destroy the several tons we had purchased. Moreover, how are we supposed to know who was correct on the matter of pesticides and other chemical residues in the feed and the milk? Furthermore, why did the federal and state sampling methods produce different results, if the Food and Drug Administration is responsible for preventing against pesticides and other harmful chemical residues from entering the human food chain?

Several of the McDonald County, Missouri, dairy farmers, my husband and I included, had been purchasing animal feed from Valet Feeds for almost two years. If there is accurate public health and safety monitoring
of human and animal food products by FDA, USDA and state agricultural extension services, how is it that the sale of this contaminated feed was not detected sooner? It seems as though, if there are good faith attempts to monitor the American public's food supply against violators of the FDA, USDA, and state extension service regulations — which we understand must be in conformity with federal regulations — how can such a contamination situation continue undetected for as long as it did?

We, as owners of dairy farms who were exposed to this unfortunate contamination situation, are truly concerned with the federal and state programs currently in effect for monitoring the nation's food products. We feel that because the pesticide contamination of this feed and our dairy milk product went undetected for as long as it did the chances are that this situation is occurring with other food products in other parts of the nation. The thought of this being possible leaves us truly concerned about the integrity of monitoring programs for a safe food supply for the American public.

To reinforce the seriousness of our concerns, we arrive at the next point which needs to be resolved with regard to federal and state management and disposal procedures for substances containing pesticide and other harmful chemical residues. Specifically, when the contamination first occurred, we were visited by FDA officials who informed us that our dairy farms were quarantined. At this time we inquired about what would be done with the contaminated milk and feed. We were told that we would be visited by EPA officials who would resolve the problem of what to do with all of this contaminated milk.

This was not the case, however. EPA officials never arrived to instruct us how to properly dispose of the contaminated milk. We telephoned the Department of Human Resources, our milk producers and other federal and state entity we could think of. During our search for a responsible official to instruct how to dispose of the milk, the only information we could gather was not to dispose of it in a fashion so as "to reach the waters of the state." (Letter dated March 31, 1986 from the State Milk Board, attached as part of Exhibit #7).

In this letter, we were instructed to contact our state Department of Natural Resources, but when we did, we received the same inadequate directions the milk board had offered. By this time, approximately one month after we were quarantined, our facilities could no longer store any of the milk. Finally, we were told to go ahead and dump the milk on our fields, or that we could contact the Department of Natural Resources and possibly have the option to dispose of it at a wastewater treatment facility. We elected to exercise the latter option but were informed that none of the wastewater treatment facilities could handle the milk loads. If the situation is that the wastewater treatment plants could not handle the milk loads, why was this method even suggested?
ENVIRONMENTAL RESIDUES

As it stands, we were not responsible for the heptachlor and pesticide residue contamination of our dairy farms. However, the state and/or government agencies that are presumably responsible for management of hazardous wastes or toxic substances have been unable to resolve the problem of where to safely dispose of the heptachlor contaminated milk. Further, we have obtained conflicting reports regarding the persistency of heptachlor and heptachlor epoxide in the soil ecosystem and human and animal food chain.

For example, in a report from the United States Environmental Protection Agency, PR Notice 78-2, it states that EPA issued a Notice to Cancel and Phase-Out Products Containing Heptachlor and Chlordane. PR Notice 78-2 was issued on November 18, 1974. The Phase-Out plan was for the duration from October 1978 through July 1983. A Final Order was issued which was to provide for the cancellation of all uses subject to the Notice of Intent to Cancel and the Notice of Intent to Deny Registration. (Report attached as Exhibit #1).

In this report, on page five (5), in the section “Field Corn” it states that treatment of field corn with heptachlor is allowed as a “Phased-Out” use and outlines how the “Phased-Out” use will be conducted:

1. Application will be broadcast with soil incorporation only;
2. *Use on dairy farms is prohibited*;
3. The following crops shall not be grown in a field treated with heptachlor in the year of treatment, (legumes, including alfalfa; root crops; oil crops; vegetable crops); silage shall not be cut from the field of application in the year of treatment or the following year.

In another report on heptachlor, entitled “Heptachlor Contamination of Livestock and Poultry and of Dairy Cattle,” a USDA Extension Service team indicated that heptachlor is eliminated from lactating animals through excretion and lactation. About heptachlor persistency in the soil, it is stated—

*Milk Disposal:* Land disposal . . . is effective in preventing environmental accumulation of heptachlor and heptachlor epoxide.

In this report the Extension Service stated—

Heptachlor and Heptachlor epoxide are broken down quickly by sunlight and more slowly by soil microbes.

In yet a third report (attached as Exhibit #3), entitled “SUMMARY” about heptachlor, excerpts on page one (1) on its soil persistency as follows:

Heptachlor has been reported to be less persistent in the soil than chlordane, *although it may be detected in the soil for as long as ten years after application*. Heptachlor may vaporize slowly from the soil; it may be oxidized to form heptachlor epoxide, a substance more persistent and toxic than the parent compound; or it may be converted to less toxic metabolites.
REPORT OF THE COMMITTEE

After reviewing the above-mentioned report, we observe contradiction with reference to heptachlor residue persistency in the soil. The second report states that heptachlor and heptachlor epoxide are "broken down quickly by sunlight," whereas the third report indicates that "heptachlor may be detected in the soil for as long as ten years after application." Which is the correct assessment of heptachlor residue persistency in the soil?

Moreover, in the report identified as Exhibit #1 it is stated that "Phased-Out" uses of heptachlor are prohibited on dairy farms. If this is, in fact, true, it seems that disposal of the heptachlor contaminated milk on our dairy farms is prohibited by the Environmental Protection Agency's very own documented workproduct and recommendations. (Exhibit #1).

The Environmental Protection Agency has maintained a low profile, at best, with regard to the heptachlor contamination and the disposal method for thousands of gallons of this heptachlor contaminated milk. In fact, we have not been contacted by EPA throughout this entire ordeal. Missouri's DNR guidelines for contaminated milk disposal do not appear consistent with EPA's very own recommendations — not to allow application of heptachlor products on dairy farms. (Exhibit #1).

We have been told by officials of the Missouri DNR that heptachlor contaminated milk is not a hazardous or toxic substance, according to EPA officials. However, we note the various statutes which EPA is responsible for administering as follows:

1. National Environmental Policy Act 42 U.S.C. Section 4321 et seq.;
2. Resource Conservation and Recovery Act 42 U.S.C. Section 6901 et seq.;

We are certain that the disposal of heptachlor contaminated milk falls square within at least one, if not several, of the above-listed statutes.

We herein request that an assessment be made regarding EPA's supposed "lack of statutory authority" for getting involved with a plan to safely dispose of the heptachlor contaminated milk. Due to EPA's significant involvement with the administration of the "Order of Cancellation of Product Containing Heptachlor and Chlordane," we believe EPA is responsible for administering an alternative to dumping the heptachlor contaminated milk on our fields. For one, some of us need to use our fields for grazing our cattle herds. If we must prevent cattle from grazing on the fields that were used as dumping grounds for heptachlor contaminated milk, (see Exhibit #1 page 6), we are likely to be further damaged. Moreover, what if the residue persistency is ten (10) years,
ENVIRONMENTAL RESIDUES

instead of one? (Exhibit #1, 3). Hence, we believe that the disposal of products containing levels of heptachlor is a federal issue. Our assumption is supported by the fact that both FDA and USDA immediately became involved with the heptachlor contamination problem. Despite its roots and prior involvement, inexplicably EPA now is holding back.

Lastly, we find it difficult to believe that dairy farms were the only industry contaminated with heptachlor and other pesticide residues. What happened with the neighboring poultry producing plants? Were they not also affected by the contaminated feed? It is a fact that our Tri-State area — Missouri, Arkansas, and Oklahoma — is a major poultry producing region. Van Buren, the location of the heptachlor contaminated feed, is dead in the heart of this area. Were not these industries also affected by the contamination?

We are submitting the above statement and questions for consideration by FDA, USDA, and EPA officials, per invitation at the July 10th meeting at USDA. We hope that you will be able to resolve the many outstanding questions which we have herein posed.

We appreciate the opportunity to submit a statement on behalf of the contaminated dairyfarm owners similarly affected.

We look forward to your responses to the issues presented in our statement.

Thank you.

Sincerely,

Mr. & Mrs. Leonard O'Neil,
on behalf of McDonald County, Missouri, Dairy Farmers

Exhibits enclosed

cc. Honorable Senator Thomas F. Eagleton
McDonald County, Missouri, Dairyfarmers:
Mr. & Mrs. Don Wright
Mr. Harold Thomas
Mr. & Mrs. George Barber
Mr. Jon Walker
Mr. Bill Cooley, Dairy Farmer, Arkansas 24206
REPORT OF THE COMMITTEE ON EPIZOOTIC ATTACK

Chairman: Mr. J. Finley, Jr., Encinal, TX
Vice Chairman: Dr. H. A. McDaniel, Silver Spring, MD

Mr. J. Adams, VA; Dr. J. B. Anderson, TN; Dr. R. A. Bankowski, CA; Mr. N. Black, MN; Dr. J. L. Blair, VA; Dr. W. W. Buisch, MD; Dr. R. G. Burdett, OR; Mr. T. Cook, DC; Dr. S. J. Couger, TX; Dr. A. H. Dardiri, NY; Dr. R. O. Drummond, TX; Dr. A. K. Eugster, TX; Dr. W. C. H. Glaze, TX; Dr. A. E. Hall, MD; Dr. F. A. Hayes, GA; Dr. P. R. Henry, CO; Dr. B. R. Heron, CA; Mrs. M. C. Howard, CA; Dr. J. L. Hyde, MD; Dr. L. L. Logan, NY; Dr. E. T. Mallinson, MD; Dr. R. H. McCapes, CA; Dr. N. Meyer, VA; Dr. M. A. Mixson, AL; Brig. Gen. T. G. Murnane, TX; Dr. J. E. Novy, TX; Dr. J. S. Osborne, Jr., CA; Dr. B. I. Osburn, CA; Dr. H. G. Purchase, MD; Dr. T. B. Ryan, NC; Dr. E. C. Sharman, MD; Dr. D. L. Thompson, CA; Dr. M. A. Van Buskirk, Jr., PA; Dr. S. A. Vezey, GA.

The Epizootic Attack Committee was called to order by Chairman Finley at 1:30 P.M., October 20, 1986. There were fifty-five members and guests present.

Dr. Edwin Pilchard presented an informative summary of computer support for animal disease outbreaks. The information management system described appeared to be well developed and ready to use in the event of an emergency disease outbreak.

Dr. Don Luchsinger, Director, Foreign Animal Disease Diagnostic Laboratory (FADL), Plum Island, updated the committee on the status of Laboratory Preparedness to diagnose foreign animal diseases. Questions posed concerned the type and quantity of reagents for foreign animal diseases that should be ready for immediate use at FADL. The committee anticipates another report on the subject next year.

Dr. Roger Drummond gave a status report on the feasibility proposal to eradicate tropical Bout ticks from the Caribbean Region.

Drs. Milbus, Acree, and Callis presented information and proposals regarding transmission of foot and mouth disease (FMD) and Bluetongue during embryo transfer. Data presented indicated embryos with intact Zona Pulicida, which were washed ten times with one washing solution containing trypsin, are free of FMD, Bluetongue and probably other pathogenic micro-organisms.

Dr. Al Smith presented new information on Calciviruses that cause vesicular disease in cattle and pigs. Contact transmission between these two species was demonstrated at Oregon State University and confirmed at PIADC.

Pete Swiderek presented an extensive proposal for model regulation for control of zoological animals. This proposal allowed for most of the authority to control movement of these animals to remain within departments of
natural resources, but would require concurrences by other agencies. A motion approving the concept of a model regulation to control zoological animals passed.

The subject of vaccines for exotic animal diseases was raised. There was not much interest in discussing this subject expressed.

A subcommittee will be appointed to study the feasibility of APHIS providing diagnostic reagents for exotic diseases to state diagnostic laboratories.

The committee passed four resolutions related to the subject matter discussed and forwarded them to the oversight committee.
REPORT OF THE COMMITTEE ON IMPORT-EXPORT

Chairman: Mr. C. Booth, Dallas, TX
Vice Chairman: Mr. D. B. Childs, Lake Placid, FL

Dr. J. A. Acree, CA; Dr. J. N. Armstrong, NV; Dr. C. T. Barns, Jr., VA;
Dr. J. L. Blair, VA; Dr. S. R. Bolin, IA; Dr. R. B. Caffey, MD; Dr. R. A.
Carmichael, IA; Dr. J. A. Cobb, GA; Mr. T. Cook, DC; Dr. R. L. Evinger,
TX; Dr. W. H. Fales, MO; Dr. A. A. Furr, MD; Dr. W. B. Grene, FL; Mr.
H. J. Hansen, VT; Mr. F. H. Harding, IL; Dr. W. C. D. Hare, Canada;
Mr. W. T. Harrer, MT; Dr. R. Harrington, CO; Dr. D. E. Herrick, MD;
Dr. W. P. Heuschele, CA; Mrs. M. C. Howard, CA; Dr. H. W. Kinne, TX;
Dr. R. C. Knowles, DE; Dr. D. C. Kraemer, TX; Dr. D. W. Luchinger,
NY; Mr. Marlin L. Main, SD; Mr. J. M. Massey, TX; Dr. B. Mathis, AZ;
Dr. J. W. McVicer, NY; Dr. C. A. Mebus, NY; Mr. M. E. Mix, VT; Dr.
R. M. Nervig, IA; Mr. M. J. Nolan, DC; Dr. R. K. Pelant, AR; Dr. W. D.
Prichard, OR; Dr. G. G. Rea, OR; Dr. S. S. Richeson, MD; Dr. T. D. Rich,
MO; Dr. J. D. Roswurm, CA; Dr. R. H. Rumler, VT; Dr. W. L. Searles,
TX; Dr. J. D. Smith, KY; Mr. S. V. Timberlake, Jr., NY; Mr. W. H.
Waldo, NE; Dr. J. S. Walker, DC; Dr. Harold A. Waters, VA; Mr. C. R.
Weston, NH; Mr. W. Wilson, TX; Dr. G. O. Winegar, MD; Dr. J. M.
Wright, TX; Dr. R. J. Yedloutschnig, NY.

The Committee on Import-Export met at 1:30 p.m. on Wednesday,
October 22, 1986, during the annual meeting of the USAHA held at the
Executive West Hotel in Louisville, Kentucky. The meeting was called to
order with 39 of the 50 members present and with a total attendance of 70
people.

The chairman asked for comments on last year’s report and none were
offered.

Dr. R. B. Caffey reviewed the past year’s activity in Plant Protection and
Quarantine (Appendix 1).

Dr. D. E. Herrick told the committee about the reorganization of the
Import-Export staff into Import-Export Operations Staff, Import-Export
Emergency Planning Staff and International Operations Staff.

Drs. D. E. Herrick, M. J. Gilsdorf and S. E. Richeson gave the report from
the Import-Export Operations Staff (Appendix 1).

Drs. R. D. Whiting and H. A. Kryder gave the report from the Import-
Export Emergency Planning Staff (Appendix 1).

Dr. George Winegar gave the report from International Operations Staff
(Appendix 1).

Dr. Michael Gilsdorf told the committee about the advantages of accessing international import-export regulations using AGNET, a computer data base. At the break, Dr. Gilsdorf and Mr. Steve Weber gave demonstrations of the AGNET system.
Drs. J. J. Callis and C. A. Mebus gave a very favorable report on the results of studies on the transmission of FMD by embryo transfer and discussed their proposed program involving imports of embryos from Brazil to be used in a controlled test at HST on Fleming Key, Florida.

Dr. W. C. D. Hare and Mr. S. V. Timberlake, Jr. gave a report on the plans and program for the International Embryo Movement Symposium to be held on August 19, 1987, as part of the XXIII World Veterinary Congress in Montreal, Canada.

Mr. S. V. Timberlake, Jr., gave a report of the Embryo Movement subcommittee meeting that was held this morning (Appendix 2).

Dr. H. A. Waters gave a report of the Export subcommittee meeting that was held on Tuesday afternoon (Appendix 3).

The committee considered and passed the following resolutions:

1. Embryo Transfer Protocol Task Force — urging representatives of the Secretary of Agriculture to meet with a task force from this committee to determine ways to accelerate the movement of embryos from the United States to other countries.

2. Embryo Disease Transmission — urging USDA to design, fund and conduct field trials to determine the probability of disease transmission by embryo transfer.

The committee adjourned at 4:45 p.m.

APPENDIX 1

APHIS REPORT TO THE IMPORT-EXPORT COMMITTEE OF USAHA

Detector Dog Program

The detector dog program, reported on last year, has been officially named the “Beagle Brigade.” It is expected that by the end of calendar year 1986, there will be eight dog teams at international-arrival airports in Los Angeles, San Francisco, John F. Kennedy International, Chicago, Dallas, and either Boston or Seattle.

This project has been one of the most successful ever undertaken by the U.S. Department of Agriculture, both in terms of effectiveness and in getting a vital message to the public.

X-Ray Baggage Inspection

Plant Protection and Quarantine (PPQ) has been using x-ray equipment in our preclearance activities in Puerto Rico and Hawaii for a number of years. The use of x-rays has proven to be a valuable asset in preclearance operations with passengers and baggage.

PPQ recently completed an x-ray test at Miami International Airport
REPORT OF THE COMMITTEE

regarding the feasibility of utilizing x-ray equipment for screening international-arriving passengers' hand and pit baggage. PPQ and the Agricultural Research Service also conducted a test in San Francisco dealing with computer enhancement and remote monitoring of x-ray screening. These tests indicated that it would be practical to screen passenger baggage through the use of x-ray equipment at large international airports.

PPQ feels that passenger baggage plays an important role in the introduction of harmful plant and animal pests. Therefore we are going forward with plans to expand the utilization of x-ray equipment for screening baggage in the international area.

The use of x-ray equipment is now being tested in the Jersey City, New Jersey, mail facility, which receives most of the international parcel mail for the Eastern United States.

Civil Penalties

Baggage:

During fiscal year 1986, 15,548 penalties assessed were against travelers who were discovered carrying prohibited animal or plant products and who had not declared these items. The “on the spot” collection rate continues to hold at 98.6 percent, far exceeding our expectations. The collection rate for penalties forwarded to PPQ's Regulatory Services Staff for followup has averaged about 70 percent, giving us a total collection rate of 99.6 percent. In April, we surpassed $1 million in cumulative penalties collected from passengers since the inception of the program.

Maritime:

During fiscal year 1986, 707 civil penalties were assessed for maritime garbage handling violations. Collection rates are about 96.9 percent. We were unable, because of difficulties in interpretation of the present garbage regulations, to collect fines on slightly more than one-third of the violations detected. An amendment to the garbage regulations is near publication and should increase our ability to levy fines. Approximately 1.5 percent of vessels boarded and/or monitored are found to be in violation of U.S. garbage regulations (900 vessels out of 59,000 boarded and/or monitored).

FISCAL YEAR 1986 REPORT OF ANIMAL PRODUCTS IMPORTED/EXPORTED
(Does not include the month of September)

Vessel and aircraft arrivals

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>40,557</td>
<td>vessels boarded</td>
</tr>
<tr>
<td>1,626</td>
<td>lots consisting of 4,476,386 kilograms of garbage were removed from these vessels</td>
</tr>
</tbody>
</table>

28
Meat and other animal products confiscated/refused entry

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship passenger baggage</td>
<td>684 lots</td>
</tr>
<tr>
<td>Aircraft passenger baggage</td>
<td>116,343 lots</td>
</tr>
<tr>
<td>Border crossing</td>
<td>34,786 lots</td>
</tr>
<tr>
<td>Post office</td>
<td>3,815 lots</td>
</tr>
</tbody>
</table>

Commercial poultry and red meat shipments rejected

<table>
<thead>
<tr>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>303 lots</td>
</tr>
</tbody>
</table>

Footwear cleaned and disinfected

<table>
<thead>
<tr>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,260 pair</td>
</tr>
</tbody>
</table>

Animal byproduct certificates issued

<table>
<thead>
<tr>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>34,484</td>
</tr>
</tbody>
</table>

Animal product import certificates reviewed

<table>
<thead>
<tr>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>38,672</td>
</tr>
</tbody>
</table>

Animal Products and Byproducts

During fiscal year (FY) 1986, 962 permits were issued authorizing the importation of restricted animal products/byproducts and controlled materials for commercial distribution. During the same time period, 1,693 permits were issued for the importation of controlled biological materials for research purposes including permits authorizing the import and interstate movement of animal disease organisms and vectors. The number of import permits from the Animal Products/Organisms and Vectors Sections in FY 1986 (2,655) is approximately 33 percent more than the number issued in FY 1985 (1,993), and 67 percent more than the number issued in FY 1984 (1,590). This trend for continuing demand for permits to import controlled materials is expected to continue to increase in FY 1987.

Changes in Disease Status for Great Britain, Northern Ireland, and The Netherlands

Great Britain was added to the list of countries where hog cholera exists on April 11, 1986. Northern Ireland was added to the list of "FMD-specified" countries due to its policy of allowing the importation of uncooked meat from countries in the European Economic Community which are not recognized by the USDA as being free of foot-and-mouth disease (FMD). On April 3, 1986, The Netherlands was added to the list of countries where African swine fever (ASF) exists.

Importation of Cooked Pork and Pork Products From Countries Where ASF Exists

A new regulation change was finalized which provides a means whereby USDA, APHIS-approved plants can export pork (cooked to a minimum internal temperature of at least 69°C) to the United States provided the
plant obtains all raw pork from ASF-free countries and complies with other provisions of the regulation. To date, four plants (two Belgian, one Dutch, and one Italian) have been approved under the provisions of this new regulation change.

**Importation of Prosciutto (Parma Hams) From Countries Where ASF Exists**

A final regulation change related to the importation of prosciutto from Italy (and other countries where ASF exists) is being considered by the USDA. A final decision is expected soon and will be published in the Federal Register.

**Revised Requirements for the Importation of Fetal Bovine Serum (FBS) into the United States**

All U.S. importers of FBS have been notified of the new restrictions on the importation of FBS which go into effect January 1, 1987. Under this new policy, FBS from countries where FMD exists is still prohibited from being imported into the United States. FBS from FMD-free countries may be imported if the U.S. importer obtains a valid USDA import permit which would stipulate the new safeguards; i.e., safety testing, gamma irradiation, or inspection of overseas slaughterhouses/processing laboratories. This new policy has been implemented to minimize the chance for exotic disease agents to enter the United States by way of FBS imports. It has been estimated that up to 30 percent of the imported FBS is used for production of livestock vaccines.

**Import Animals**

There were no animals imported through the Harry S Truman Animal Import Center (HSTAIC), Fleming Key, Florida, in FY 1986. Several applicants who wanted to use the facility on an exclusive use basis for llamas and alpacas failed to exercise their option to use the facility. There has been considerable demand to use HSTAIC in FY 1987 for llamas and alpacas from Bolivia, a research project for bovine embryos, and possibly swine from the People's Republic of China (PRC).

In June 1986, USDA signed an agreement with officials from the PRC on conditions for importing swine from that country. No agreement was reached on importing swine semen, but officials from the PRC have been given a proposed protocol for swine semen which they will review for future negotiations.

The first two projects in Brazil for importing bovine semen from bulls vaccinated for FMD were completed in FY 1986. A third project is scheduled to be initiated in November 1986. USDA regulations were amended in 1985 to permit vaccinated bulls to be used as semen donors.

A notice was published in the Federal Register on May 30, 1986, regarding comments on a proposal to contract out certain functions at
IMPORT-EXPORT

USDA animal import centers. A public meeting was held on July 23, 1986, in Hyattsville, Maryland, in order to allow interested parties a chance to comment on the proposal. A series of evaluations have been scheduled in FY 1987 in order to determine the feasibility of contracting out certain functions now performed by Federal personnel.

A request by Chile to be declared free of FMD is still under consideration in the USDA. Request by the Fiji Islands and Panama to be recognized free of hog cholera, Belgium to be free of African swine fever, Morocco to be free of African horsesickness, and the Fiji Islands to be free of viscerotropic velogenic Newcastle disease (VVND) and swine vesicular disease are also currently being evaluated by the Department. Norway was added to the list of countries affected with contagious equine metritis (CEM) in July 1986.

Twelve States (California, Colorado, Kentucky, Louisiana, Maryland, New York, North Carolina, Ohio, South Carolina, Tennessee, Virginia, and Wisconsin) have been approved to complete the treatment and testing of stallions for CEM. Eleven States (California, Colorado, Kentucky, Louisiana, Maryland, New York, Ohio, South Carolina, Tennessee, Virginia, and Wisconsin) have been approved for the treatment and testing of mares for CEM.

The veterinary colleges of Ithaca, New York, and Davis, California, are approved to do corrective surgery for incomplete sinusectomies.

A final rule was published in the Code of Federal Regulations to allow importation of animal embryos from countries free of FMD.

### ANIMALS IMPORTED

<table>
<thead>
<tr>
<th></th>
<th>FY 1983</th>
<th>FY 1984</th>
<th>FY 1985</th>
<th>FY 1986 (estimated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>1,224,076</td>
<td>787,724</td>
<td>533,364</td>
<td>896,976</td>
</tr>
<tr>
<td>Swine</td>
<td>416,224</td>
<td>1,066,056</td>
<td>1,424,677</td>
<td>488,731</td>
</tr>
<tr>
<td>Horses</td>
<td>36,232</td>
<td>35,776</td>
<td>34,112</td>
<td>25,742</td>
</tr>
<tr>
<td>Sheep</td>
<td>9,980</td>
<td>13,362</td>
<td>22,965</td>
<td>10,597</td>
</tr>
<tr>
<td>Others</td>
<td>3,494</td>
<td>8,419</td>
<td>8,129</td>
<td>3,010</td>
</tr>
<tr>
<td>Total</td>
<td>1,690,006</td>
<td>1,911,337</td>
<td>2,043,247</td>
<td>1,425,056</td>
</tr>
</tbody>
</table>

#### CATTLE

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Canadian Ports</td>
<td>457,550</td>
<td>348,982</td>
<td>374,242</td>
<td>289,628</td>
</tr>
<tr>
<td>Air &amp; Ocean Ports</td>
<td>150</td>
<td>221</td>
<td>62</td>
<td>1,059</td>
</tr>
<tr>
<td>Mexican Ports</td>
<td>766,376</td>
<td>438,521</td>
<td>179,060</td>
<td>606,289</td>
</tr>
<tr>
<td>Total</td>
<td>1,224,076</td>
<td>787,724</td>
<td>553,364</td>
<td>896,976</td>
</tr>
</tbody>
</table>

#### SWINE

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Canadian Ports</td>
<td>416,056</td>
<td>1,066,014</td>
<td>1,424,555</td>
<td>487,548</td>
</tr>
<tr>
<td>Air &amp; Ocean Ports</td>
<td>168</td>
<td>42</td>
<td>122</td>
<td>1,183</td>
</tr>
<tr>
<td>Total</td>
<td>416,224</td>
<td>1,066,056</td>
<td>1,424,677</td>
<td>488,731</td>
</tr>
</tbody>
</table>
REPORT OF THE COMMITTEE

HORSES

<table>
<thead>
<tr>
<th></th>
<th>Canadian Ports</th>
<th>Air &amp; Ocean Ports</th>
<th>Mexican Ports</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>27,227</td>
<td>27,395</td>
<td>26,547</td>
<td>17,913</td>
</tr>
<tr>
<td></td>
<td>4,536</td>
<td>5,175</td>
<td>4,998</td>
<td>6,023</td>
</tr>
<tr>
<td></td>
<td>4,469</td>
<td>3,206</td>
<td>2,567</td>
<td>1,806</td>
</tr>
<tr>
<td></td>
<td>36,232</td>
<td>35,776</td>
<td>34,112</td>
<td>25,742</td>
</tr>
</tbody>
</table>

Construction

Sweetgrass, Montana — Construction should be completed by the end of the fiscal year.

Detroit, Michigan — Still under consideration by the Department as to whether it will be constructed or not and if funding is available.

Canadian Border Port Facilities — A survey will be made to determine future needs of the Canadian border facility.

Export Animals

As reported last year, the import health requirements of other countries are available to Veterinary Services (VS) area offices through the International Regulations Retrieval Systems (IRRS), located in Ft. Collins, Colorado. On October 1, 1986, this export information was made available to private exports and veterinarians through the Agnet computer network. This system requires continual updating by the Import-Export Operations Staff in Hyattsville, as new requirements are developed. For VS offices which have not yet had computers installed, hard copies of the import requirements of foreign countries are distributed as VS memoranda.

A plane load of 139 cattle being exported to Venezuela, experienced mechanical difficulties while departing from the Miami International Airport. Before the animals could be off-loaded, 75 animals died. Poor ventilation resulting in increased temperature was the primary cause of death.

The United States remained free of lethal avian influenza this year. However, outbreaks of low and nonpathogenic strains occurred in Massachusetts, New Jersey, New York, Pennsylvania, and Ohio. This caused concern by several countries which imposed bans and/or restrictions on U.S. poultry and hatching eggs.

The Livestock Export Task Force met twice this fiscal year. The purpose of this group is to promote and improve the quality of U.S. export livestock through liaison and cooperation between the industry and Government. Recommendations developed during the meetings are in the process of being implemented.

Continued discussions with Canadian animal health officials have resulted in amended requirements for sheep, goats, pigeons, and slaughter/feeder cattle. New requirements for brucellosis and bluetongue are still being developed for breeding cattle. The bluetongue requirements will be
IMPORT-EXPORT

different for cattle imported from low, medium, and high risk States.

The dairy termination program has stimulated interest by individuals in several countries to import U.S. dairy cattle. New animal health agreements were signed with Moroccan, Venezuelan, Indonesian, and New Zealand animal health officials for the export of breeding cattle in FY 1986. Negotiations are also underway with Iraq, Turkey, Tunisia, Algeria, Syria, and other countries. Indications are that more than 30,000 head of dairy cattle may be imported by these countries in the next several years.

New health requirements for embryos and semen were developed with Australia, Great Britain, New Zealand, Ireland, Philippines, Switzerland, Brazil, Israel, Italy and China.

Four shipments of cattle totaling 649 head were exported to the PRC in FY 1986. A new protocol was developed and signed in December 1985. Testing must take place between November 1 and April 15 each year and the animals must originate from 18 northeastern States. Earlier this year, 70 animals in a shipment of 293 animals exported to the PRC were destroyed while in quarantine, primarily because of titers to IBR-BVD viruses. Two shipments of swine totaling 3,296 head, were also exported to the PRC this fiscal year.

The Tripartite countries (England, France, and Ireland) reduced equine viral arthritis requirements for horses from the United States. The horses must still be isolated in a USDA approved facility for 30 days, but now the isolation facilities can be located in any State.

Vesicular stomatitis was diagnosed in Colorado this fiscal year. Taiwan and China will not accept livestock from States where vesicular stomatitis was diagnosed during the 12 months prior to export.

<table>
<thead>
<tr>
<th>LIVESTOCK EXPORTS FY 1985</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Canada</strong></td>
</tr>
<tr>
<td>Cattle</td>
</tr>
<tr>
<td>Horses</td>
</tr>
<tr>
<td>Sheep</td>
</tr>
<tr>
<td>Swine</td>
</tr>
<tr>
<td>Total Livestock</td>
</tr>
<tr>
<td>Baby chicks, breeding</td>
</tr>
<tr>
<td>Baby chicks, not breeding</td>
</tr>
<tr>
<td>Turkey poults</td>
</tr>
<tr>
<td>Other baby poultry</td>
</tr>
<tr>
<td>Live poultry, not baby</td>
</tr>
<tr>
<td>Total Live Poultry</td>
</tr>
<tr>
<td>Hatching eggs (dozen)</td>
</tr>
<tr>
<td>Bull semen</td>
</tr>
</tbody>
</table>

33
## REPORT OF THE COMMITTEE

### LIVESTOCK EXPORTS FY 1986 (THROUGH AUGUST 31, 1986)

<table>
<thead>
<tr>
<th>Livestock Type</th>
<th>FY 1986 Export Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>13,877 62,172 19,951 96,000</td>
</tr>
<tr>
<td>Horses</td>
<td>10,661 2,329 3,010 16,000</td>
</tr>
<tr>
<td>Sheep</td>
<td>23,109 140,702 2,189 166,000</td>
</tr>
<tr>
<td>Swine</td>
<td>383 3,075 10,542 14,000</td>
</tr>
</tbody>
</table>

**Total Livestock:**

- **Bull semen**
  - 2,704,184 432,385 10,542 292,000
  - **$1,020,584** $1,527,637 $20,922,657 $23,470,878

### Avian Import Activities

#### A. Commercial Bird Program

1. Approximately 700,000 commercial pet birds were imported through 83 USDA approved private quarantine stations and five USDA facilities.

2. There were nine VVND infected commercial bird lots from seven countries. The countries were: India, Indonesia, Malaysia, Peru, Philippines, Tanzania, and West Germany.

3. Two shipments of birds were quarantined in the HSTAIC during FY 1986. Bulk quarantine rates have been established for shipments of birds through HSTAIC.

4. A proposed rule was published to extend the time for 9 months for the USDA approved bird stations in Detroit to relocate to Miami. Several owners expressed a desire to remain in Detroit permanently.

5. There has been renewed interest by Hartz Mountain and the Government of St. Lucia in the closed parakeet breeding colony. St. Lucia is taking action to meet VVND free status requirements.

#### B. Pet Bird Program

1. Approximately 2,000 personally owned pet birds were quarantined in USDA facilities during FY 1986.

2. An interim rule has been published to remove Nogales, Arizona, El Paso, Texas, and Laredo, Texas, from the list of special ports for entry and quarantine of pet birds. These ports had very limited numbers of pet bird entries and the closing was an economic necessity.

#### C. Smuggled Bird Program

1. The two smuggled bird facilities located at Mission, Texas, and Otay Mesa, California, are quarantining and auctioning most of the smuggled
IMPORT-EXPORT

birds that are seized.

2. An agreement was reached with U.S. Fish and Wildlife Service, Law Enforcement Branch, on charges and collection of fees for seized birds placed in quarantine.

3. A holding rate for birds held after quarantine has to be developed and implemented.

4. There were seven lots of seized birds positive for VVND during FY 1986.

D. Poultry and Hatching Egg Imports

1. Poultry hatching eggs and day-old chick imports remained near last year's level.

2. The USDA proposed regulations to allow hatching eggs from VVND free countries to be imported without further quarantine was published. A final rule is pending.

3. Additional restrictions have been placed on the importation of turkey hatching eggs from the United Kingdom due to turkey rhinotracheitis. Conditions for importations include certification of testing and the use of sentinel birds placed in the flock of origin. Upon arrival, the poults will be quarantined for 8 weeks and must be serologically and clinically negative for rhinotracheitis prior to their release.

4. Atlanta, Georgia, was added as a limited port of entry to accommodate hatching eggs destined for southeast United States.

APPENDIX 2

REPORT OF THE EMBRYO MOVEMENT SUBCOMMITTEE

Chairman: Mr. S. V. Timberlake, Jr., Pelham Manor, NY

Dr. S. R. Bolin, IA; Mr. C. Booth, Ex Officio Member, TX; Dr. R. A. Carmichael, IA; Mr. D. B. Childs, Ex Officio Member, FL; Dr. J. A. Cobb, GA; Mr. H. J. Hansen, VT; Dr. W. C. D. Hare, Canada; Dr. W. P. Heuschele, CA; Dr. D. C. Kraemer, TX; Dr. D. W. Luchsinger, NY; Mr. J. M. Massey, TX; Dr. C. A. Mebus, NY; Dr. T. D. Rich, MO; Dr. E. T. Thorne, WY; Dr. H. A. Waters, VA; Dr. G. O. Winegar, MD; Dr. J. M. Wright, TX.

The meeting was called to order at 10:00 a.m., October 22, 1986. Committee members present included Clint Booth, Dick Carmichael, Dan Childs, Howard Hansen, Doug Hare, Harold Waters, and George Winegar. Absent were Drs. Cobb, Heuschele, Kraemer, Luchsinger, Massey, Rich, Thorne, and Wright.

There were forty-five persons in attendance including committee members as per the attached sign-in sheet.

The chairman introduced Drs. Callis and Mebus who gave their report.
on the results of studies on the transmission of foot and mouth disease by embryo transfer and the forthcoming program involving imports of embryos from Brazil to be used in a controlled test at Fleming Key, Florida. The chairman presented the embryo disease transmission resolution passed by the Epizootic Attack Committee that had been forwarded to him for similar approval by the embryo movement subcommittee. The resolution was passed unanimously. A copy of the resolution is attached.

The chairman then introduced Dr. Richard Carmichael who gave a brief talk about the urgent need for a task force consisting of members of this committee to meet with representatives of the Secretary of Agriculture prior to December 1, 1986, and stress the need for correlating current restrictive export import regulatory procedures with well established current scientific data supporting the safe movement of genetics worldwide; and to establish protocol which would accelerate the movement of embryos between the U.S. and countries abroad. Dr. Carmichael presented the attached resolution for an embryo transfer protocol task force which was passed unanimously.

The chairman introduced Drs. Winegar and Herrick of APHIS who gave their reports on imports and exports and international programs.

The chairman read the resolution passed by the Import-Export Committee at the Milwaukee meeting of USAHA held October 28–November 1, 1985, that urged the USDA/APHIS to sponsor a symposium on the international movement of embryos attended by research, regulatory, and industry. The chairman reviewed his committee’s work over the past year in this regard and confirmed that plans had been finalized to hold a one day symposium on August 19, 1987, at the World Veterinary Congress in Montreal, Canada. The working committee members are as attached. The general chairman is Shelby Timberlake and the scientific chairman is Dr. W. C. D. Hare. Approximately twenty leading scientists in embryo transfer from around the world have been invited by Dr. Hare to participate in the symposium.

Funds available to our symposium committee are limited to the symposium so it is hoped that participants will be able to obtain expenses from other sources. Nevertheless, the symposium committee urgently is seeking monies from foundations, private industry, breed associations and government agencies. The cost for each participant would cover round trip air fare, two nights hotel lodging, $50.00 per day for food, ground transportation, plus registration fee for the full week convention which is $145.00 for non-veterinarians, $375.00 for veterinarians, and $275.00 per day for the Hospitality Suite. The proceedings of the World Veterinary Congress will include abstracts of the embryo symposium papers, however the symposium committee will print up its own proceedings which will contain the complete papers of the participants. We will need funds for this publication also. We estimate the total funding needed will be $50,000.
IMPORT-EXPORT

A pro forma copy of a resolution initiated by Dr. Harold Waters proposing the development of mechanized washing procedures for embryos and the establishment of a specialized category for licensing in conjunction with veterinary accreditation was unanimously rejected at this time. It was the feeling that current procedures already in place were more than adequate to satisfy current registration in force.

The committee adjourned at 12:00 noon.

APPENDIX 3

REPORT OF EXPORT SUBCOMMITTEE

Chairman: Dr. H. A. Waters, Annandale, VA

Mr. C. T. Barns, Jr., VA; Dr. J. L. Blair, VA; Mr. C. Booth, Ex Officio Member, TX; Mr. F. H. Harding, IL; Mr. M. E. Mix, VT; Mr. M. J. Nolan, DC; Dr. R. K. Pelant, AR; Dr. T. D. Rich, MO; Dr. W. L. Searles, TX; Mr. S. V. Timberlake, Jr., NY; Mr. W. H. Waldo, NE; Mr. C. R. Weston, NH; Dr. G. O. Winegar, MD.

The committee meeting was convened at 1:30 p.m., October 21, 1986, in the Tweed Room of the Executive West Hotel, Louisville, Kentucky; twenty-two committee members and observers were present.

Papers were presented by Drs. George O. Winegar of APHIS and Robert Fetzner of FSIS, USDA. Copies of these papers are attached.

Remarks were also made by Mr. Maurice Mix, American Holstein Association, and Mr. Tom Cook, National Cattlemen’s Association, regarding the role of the USDA Cooperators in the foreign market development of livestock and meat.

It was recognized that the Gramm Rudman Hollings Act had impaired the ability of APHIS to respond (as in the past) to the livestock market development activities of the USDA Cooperators. However, to date there had been no similar impairment (but rather an enhancement) of FSIS ability to respond to the meat and poultry market development of USDA Cooperators.

The meeting was adjourned at 3:30 p.m.

EFFECTS ON EXPORT ENHANCEMENT ACTIVITIES OF APHIS DUE TO REORGANIZATION AND BUDGET CUTS

I would like to thank you for the opportunity to discuss the effects of budget cuts by Congress and a reorganization within our headquarters staff on our ability to service the export livestock industry.

The Pacific Consulting Company, a private management company, was contracted to review the headquarters staff operations and make recommendations on how to improve efficiency and increase long term planning affecting our relationship with various segments of agriculture. The group
surveyed the headquarters staff by means of questionnaires and personal interviews to obtain a better understanding of how the mission of Veterinary Services was being carried out. They also queried our field stations by means of questionnaires to determine perceptions of field personnel on how various programs functioned.

As a result of the study it was determined that the import/export staff functions should be divided into three separate components to better carry out the responsibilities of Veterinary Services in this area. One of the goals of the study was to reduce the number of staff positions. As a result, twenty-six (26) headquarters staff positions were eliminated including some secretarial positions in the import/export staff. A staff group was formed that could respond to the Veterinary Services field personnel and to calls from the public relating to specific export shipments. Another functional group was formed having responsibility for negotiating with foreign governments to develop protocols for the export of U.S. livestock that our exporters can meet. The same staff group is responsible for contacting the animal health officials of other countries when disease problems develop in U.S. livestock in the other country. The third staff group is responsible for long range planning. This functional group assists in changing regulations having long term effects. They are also responsible for developing APHIS procedures for responding to long term anticipated changes in the exporting field.

Based on the descriptions of functions just mentioned, the first staff group (Day to day operations), was placed in the Domestic Operations Staff, the second group (Negotiating) in the International Operations Staff, and the third group (Planning) in the National Program Planning Staff.

Reorganization, whether in private industry or government, causes some disruption in channels of communications and in response time until the newly formed groups resolve methods of approach to problems and fully understand what the new ground rules are. Disruption occurred as a result of this reorganization and some time has been needed to iron out the new wrinkles that were found. Many of those wrinkles have now been ironed out and we believe that you will soon be able to see the positive effects that were hoped for by reorganizing.

The new system will provide for a closer working relationship between International Operations Staff personnel in foreign countries, the Foreign Agricultural Service and the export animals staff that was previously experienced. This relationship should prove beneficial during future negotiations or on following up on disease investigations in U.S. animals in foreign countries.

Having an export animal group in Domestic Programs will permit line direction to VS station personnel on export matters that was not possible prior to the reorganization.

At present there are two veterinarians covering export matters in
Domestic Programs and one in International Operations. Training for backup coverage is underway within the International Operations Staff.

The Gramm Rudman Hollings Act caused a 4.3% reduction in funding, agency wide. There are no options offered in The Gramm Rudman Hollings Act. Each line item must take the 4.3% reduction (i.e. import/export, brucellosis, etc.). Efficiencies in procedures will have to help recoup the loss of personnel.

“Early Out” retirement was offered Agency wide to help prepare for the further reductions anticipated in 1987–88. Sixty-six (66) full time personnel took advantage of the early retirement and have left Veterinary Services. This reduction in field and Hyattsville Staff could be expected to reduce our capability to assist in the export of U.S. livestock. However, the Secretary of Agriculture, the Administrator, and Deputy Administrator have all indicated a high priority for facilitating exports from the U.S. and we do not expect to reduce our service to the export industry.

During this past fiscal year there has been a greatly increased activity in export of dairy cattle due to the Dairy Cattle Termination Program of USDA. Countries to which we have not exported, except on a very infrequent basis or not at all, in recent years have proposed importing large numbers of U.S. dairy cattle. Many of these countries imported cattle several years ago with only a tuberculosis and brucellosis test but have now requested a large battery of tests. Negotiation has been necessary in many cases and it has often not been very rapid. It appears at this time that fairly large numbers of Dairy Termination cattle will be exported to Indonesia, Egypt, Morocco, Algeria, Syria, Iraq, Turkey, and Venezuela. Many of these animals will be exported by sea so the shipments will contain several hundred animals.

It will take extra coordination between exporter, our area offices, and the port veterinarians to facilitate the movement of these animals with a somewhat smaller Veterinary Services staff.

Working together in a creative manner, we will be able to continue to export large numbers of high quality, healthy animals that will keep importers coming back to the United States again and again.

Dr. George Winegar

Remarks on Food Safety and Inspection Service, International Program Activities to Facilitate the Exportation of U.S. Meat and Poultry

FSIS’s Strategic Plan for fiscal years 1988–1992 addresses exports in the following manner:

FSIS will support industry efforts to expand trade by working closely with U.S. industry and Government agencies to identify and monitor regulatory impediments to potential markets and negotiate with foreign countries to reduce or remove such obstacles to overseas business.
poultry inspection systems. This always pays off with more liberal acceptance of our products in their countries. These efforts will continue with other countries in the area.

But, by far, the most critical activities of the Export Coordination Division, in the past year, have been the Agency's response to the European Economic Community's (EEC) directives establishing the rules receiving countries for U.S. product. We in the Export Coordination Division (ECD), International Programs, conduct an active dialogue with foreign officials. These discussions are designed to gain acceptance of U.S. inspection procedures and program policies without additional burdensome requirements. The U.S. meat and poultry industry currently exports to about 57 foreign markets. Each foreign country has different and varied requirements. Several countries require onsite review of the U.S. inspection system and establishment facilities. During FY 1986 close to 600 foreign plant reviews were administered by FSIS. These foreign reviews are managed by ECD.

Our staff has tried to assist the export industry in developing production and certification procedures for meat and poultry products not traditional in U.S. commerce but meeting the acceptability standards of foreign markets. Unscalded beef stomachs, hide-on calves feet, and sheep heads, and poultry gizzards with the mucosa intact are exported to foreign processors for further fabrication and finishing. Ducks with feet, heads, trachae and esophagi attached are exported to Singapore as finished product to enter that country's traditional market. Other non-traditional items, such as dried protein concentrates derived from blood, milk, and meat, are being considered for export to foreign commerce.

We try to alleviate the burden of some foreign regulatory impediments to U.S. exports by having them rolled back before they are enforced. In a recent situation, Saudi Arabia considered requiring freezing of fresh cuts within 72 hours after slaughter. Industry officials and agency personnel will demonstrate to the Saudi health officials via scientific documentation and academic seminar exposure that this is an overly restrictive regulation. A similar import requirement concerning edible organs imported to Egypt is also being approached in this manner.

We are currently developing a strategy directed toward establishing better 2-way communication with countries receiving our products. We want to know if the receiving countries are happy with our products. We want them to understand that the United States wants to keep its market in their country.

We have put considerable effort into nontraditional markets such as the Near East, Far East, and South East Asia. With the Foreign Agricultural Service, we have supported visits by veterinary health officials representing the Mid-East and Pacific rim countries to the United States. These officials become acquainted with U.S. animal disease control and meat and
The policy intent, while recognizing that the Agency has a limited mandate in the international trade arena, is that FSIS will support the Administration's efforts in seeking means to expand trade by working closely with industry and cooperating with the appropriate Federal and State agencies and foreign governments.

One of our primary activities is developing regulatory flexibility in and requirements under which non-member countries will be allowed to export to Member States. FSIS has nominated 264 U.S. establishments for review by the Community's veterinary committee for consideration for permanent eligibility to export into this market. These reviews will be completed on October 31, 1986, and the list of plants permitted to export to the EC will become effective January 1, 1987.

The EEC has not, as yet, indicated, if any U.S. plants have been successful. We do expect to know before December 1986 which plants the Standing Veterinary Committee has recommended to the Member States for eligibility to trade in this market.

The directive outlawing the use of anabolics in product exported to Europe is our next problem. There appears to be an upsurge of public opinion in Europe supporting the discontinuation of using these substances in food producing animals. FSIS has the lead for USDA developing strategies to deal with this very serious threat to our exports. You will be hearing more about this in the next few months.

Robert E. Fetzner, Director
Export Coordination Division
International Programs
REPORT OF THE COMMITTEE ON PARASITIC DISEASES AND PARASITICIDES

Chairman: Dr. M. G. Scroggs, Tulsa, OK
Vice Chairman: Dr. A. R. Burgess, Cheyenne, WY

Dr. L. G. Biehl, IL; Dr. R. E. Bohlender, NE; Mr. A. A. Chadwick, DE; Dr. J. E. Christy, IL; Dr. G. P. Combs, MD; Dr. R. O. Drummond, TX; Mr. R. Gadd, SD; Mr. B. Gallagher, SD; Dr. S. C. Gartman, TX; Mr. R. Hack, DE; Mr. R. D. Jones, SD; Mr. D. Kimbrell, AR; Dr. H. W. Kinne, TX; Dr. M. H. Lang, IA; Dr. R. E. Lowe, FL; Dr. R. P. McDonald, TX; Dr. C. H. Miranda, SC; Dr. J. R. Pemberton, IA; Dr. R. L. Pyles, NM; Dr. P. L. Smith, CA; Dr. R. K. Strickland, IA; Dr. W. Utterbeck, CA; Dr. J. M. Vetterling, NE; Dr. G. L. Zimmerman, OR.

This Committee met on Thursday, October 23, 1986, at the Executive West Hotel, Louisville, Kentucky.

The meeting was called to order by Dr. Scroggs, Chairman. Forty-two persons were in attendance, eleven of which were Committee members.

Dr. R. O. Drummond, USDA, ARS, (retired), Kerrville, Texas, reported on heartwater and the tropical bont tick in the Caribbean. Dr. Drummond reviewed the life cycle of the tick. He reported that while the Virgin Islands are free of this tick, deaths from heartwater occur on the island of Guadeloupe, Marie-Galante and Antigua. Ticks are found on cattle egrets which can provide a means of spread from island to island. Also, in addition to cattle and egrets, goats, horses, swine, sheep and dogs can harbor adult ticks.

Dr. Drummond reported that a feasibility study group had been formed consisting of several governmental agencies. The study group feels the tick can be eradicated and, further, once this is done they feel the tick can be prevented from being reintroduced. Dr. Drummond reminded the Committee that we have in the U.S. a vector of heartwater disease—Amblyoma maculatum. Mexico also has a tick capable of transmitting this disease.

A resolution relating to the eradication of Amblyoma variegatum, and supported by the Epizootic Attack and Foreign Animal Diseases Committees, was presented to the Committee. This resolution was passed and is referred to the Resolutions Committee.

Dr. Drummond reported on the resistance of horn flies to pyrethroids in insecticidal ear tags. Dr. Drummond said the genetics of resistance appears to be sex-linked and is carried by the female. After three or so years of use of the insecticidal ear tags, this method of control becomes less effective.

A resolution relating to accelerated research efforts in the development of non-pyrethroid insecticides and, further, the development of a resistance test kit was presented to the Committee. This resolution was passed.
and is referred to the Resolutions Committee.

Dr. Drummond reported on the resistance of cattle fever ticks to organophosphates. This is of importance in that our dipping vats on the U.S.-Mexico border use Coumaphos. Some ticks will survive 0.85 Coumaphos. Amitraz may not be the answer to this problem because of its poor vat characteristics. The use of sterile male ticks is being studied.

Dr. Thomas J. Holt, USDA, APHIS, VS, and Dr. Francisco Zayas-Seijo, PRDA, VS, presented an interesting and informative update on the tick eradication program in Puerto Rico. It has been necessary to expand the quarantine zone on the island. It is estimated that about two-thirds of the island is under quarantine. Program procedures have been rewritten and more emphasis placed on surveillance and enforcement. The use of a computer is of great assistance in this regard. In general, the program has industry support.

Dr. M. G. Scroggs, Manager, Technical Service, Southwest Region, MSD AGVET, Merck and Company, Incorporated, reported on cysticercosis in beef cattle. Slaughter figures for 1984, 1985 and three-quarters of 1986 were presented; figures obtained from USDA, FSIS.

Dr. Chester Gipson, USDA, APHIS, VS, reported on regulations pertaining to treatment for parasites of imported zoological animals. Dr. Gipson reported that there will be pre- and post-entry treatment requirements. These regulations are about ready for final rule.

Dr. Gary Zimmerman, Oregon State University, provided the Committee with an update of the Nematodirus battus survey of sheep conducted by USDA, APHIS, VS. Thirty-three thousand samples were submitted and positives shown in Oregon, Washington, Vermont, New York and Maryland. Dr. Zimmerman encourages continued surveillance in the above states. A resolution was presented to joint cooperation between USAHA, USDA, American Association of Veterinary Parasitologists (AAVP), the livestock associations and the animal health industry to encourage interdisciplinary physiology, nutritional, immunology and parasitology research teams to develop integrated parasite management methods for improved livestock health and production. This resolution was passed and is referred to the Resolutions Committee.

Dr. Ralph Williams, extension entomologist, Purdue University, gave an informative presentation on external parasites of swine, namely lice and hog mange mites. He discussed the incidence of these parasites in Indiana correlating a survey he conducted to one taken by veterinary practitioners. Also, Dr. Williams stressed that the stable fly and Culex and Aedes mosquitoes transmit eperythrozoonosis.

Dr. Scroggs presented information on Ivomec, a newly approved anti-parasitic agent for swine. Dr. Scroggs covered the spectrum of activity of this parasiticide, safety and lack of toxicity. He noted the dose for swine is
300 mcg per kilogram versus 200 mcg per kilogram in cattle and horses. Withdrawal time before slaughter is 18 days for swine versus 35 days for cattle.

Dr. Homer Connell, technical service representative for Pfizer, presented technical information on Rumateel as a parasiticide for lactating dairy cattle. He pointed out that no milk discard is required; however, there is a 14 day withdrawal period prior to slaughter. Dr. Connell discussed the advantages of Paratect, a sustained release bolus that releases small quantities of morantel.

This Committee adjourned after a very informative meeting.
The Committee met at 1:30 p.m. October 21, 1986 at the Executive West Hotel in Louisville, Kentucky. Fifteen committee members and 12 guests were in attendance.

Mr. Scott Chandler of International Minerals and Chemical Corporation reviewed the directive approved by the European Parliament in December, 1985, banning the use of hormones for anabolic growth promoting purposes in EEC member states. The directive would also prohibit the importation into the European Community of meat derived from animals treated with such products irrespective of residue safety considerations and official approval of the use of the product in the meat exporting country. The effect on BGH usage is unclear at this time.

In approving the directive, the European Parliament ignored the advice of its own appointed panel of scientific experts which believes that the use of currently licensed products does not result in unsafe substances in food. The EEC also ignored opposition to the edict by the U. S. Government in that it represented a non-tariff trade barrier. It is widely believed that the ban on the use of approved and demonstrably safe and effective anabolic products will result in the uncontrolled use of unlicensed and potentially less safe products. Additionally, a chilling effect on current efforts toward development of new performance enhancing agents may result.

The hormone ban directive has the potential to severely disrupt international trade of meat products by banning the import of meat produced by the majority of countries, including the U. S., which have approved the safe use of anabolic implants.

Based on the concerns relative to the action by the EEC, the Committee recommends a resolution that the USAHA strongly urge the USDA, the Office of Trade, and Congress to take whatever actions are necessary to discourage the European Economic Community from implementing the restriction or ban on importation of meat derived from animals treated
REPORT OF THE COMMITTEE

with animal drug implants approved by the U. S. Food and Drug Administration.

Dr. M. L. Crandall of FDA’s Center for Veterinary Medicine reviewed the current activities of the U. S. delegation to the Codex Committee on Residues of Veterinary Drugs in Foods.

The Codex Alimentarius Commission (CAC), an arm of the Food Agriculture Organization (FAO) and World Health Organization (WHO), was formed in 1962 to implement the Joint FAO/WHO Food Standards Program. The purpose of the program is to protect the health of consumers and to ensure fair practice in food trade. It acts to develop food standards and, after acceptance of these standards by governments, publishing them in a Codex Alimentarius either as regional or worldwide standards.

The CAC is made up of 128 member countries. All meetings of CAC and its subsidiary bodies are intergovernmental meetings attended only by government delegations. Thus the inputs and recommendations may reflect national policies as well as scientific considerations. Following a 1984 joint FAO/WHO consultation to consider the question of the acceptance and safety of residues of veterinary drugs in food, the CAC at its 16th session established the Codex Committee on Residues of Veterinary drugs in Food (CC/RVDF). The United States was chosen as the host country and Dr. L. M. Crawford was chosen as chairman. Dr. Gerald Guest of FDA’s Center for Veterinary Medicine was selected as the United States delegate to this committee and Dr. Richard Ellis, FSIS, USDA, was selected as the alternate delegate. The first session of the CC/RVDF will be held at the State Department in Washington, D.C. on October 27–31, 1986.

The U. S. Delegation to the committee has met three times in preparation for the October meeting. One of the first tasks was to establish a list of veterinary drugs for which it felt should be given priority consideration by the committee. The following drugs were recommended because each has unresolved safety concerns which could become barriers to exports or imports:

1.) Endogenous and exogenous hormones for meat production
2.) Nitromidazoles
   a.) ipronidazole
   b.) dimetridazole
3.) Carbadox
4.) Chloramphenicol
5.) Sulfamethazine

At the October meeting of the CC/RVDF, a priority list of veterinary drugs will be established based upon the recommendations of various countries. This list will be sent to the FAO/WHO Joint Experts Committee for an “acceptable daily intake” for each drug to be determined from all available data. The U. S. delegation has recommended the names of
various U. S. experts in veterinary drugs as potential members of this committee.

While the above described processes will be time consuming, they offer hope that worldwide standards for "acceptable daily intakes" of residues of various animal drugs may eventually be established. The existence of such standards should reduce the potential for local or regional restrictions as illustrated by the recent hormonal ban by the European Community.

Dr. Thomas K. Shotwell, President, Shotwell and Carr, Inc. reviewed major differences in the regulation of animal drugs and animal pesticides in the United States. The Federal Food, Drug, and Cosmetic Act (FDCA) under which animal drugs are registered was conceived, negotiated and passed in its present general format in 1938. The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) under which animal pesticides are approved was conceived, negotiated and passed in its present general format in 1947. Both were made effective prior to the development of modern pharmaceutical technology. Both acts address the technology of the 30s and 40s and both have been amended several times in order to correct defects created by attempts to stretch the fabric of law to cover critical areas of regulatory concern about safety, effectiveness or environmental issues.

Within the pesticides law is a pivotal assumption that the regulated merchandise is a "poison," a toxic material which requires careful labeling. Only in recent years has the idea of banning a product been considered. The FIFRA is basically a law to assure that poisons carry proper warnings. The drug law is remarkably different. Under the paradigms of 1938, drugs needed Federal regulations to prevent consumer fraud. The outrageous claims of "patent" medicines in the late 1800s and early 1900s could not be tolerated and it was the inadvertant use of automobile antifreeze in a drug product, not the toxicity of the active ingredient in the product, which introduced the idea that drugs needed some Federal scrutiny for safety. Thus the two laws are conceptually different. One regulates the labeling of poisons and the other regulates the claims and the safety margins of medicines. The conceptual differences have profound effects on the time and cost for obtaining federal registration of a given new product for veterinary use.

Drug and pesticide substances and their uses in animal health are quite similar; their pharmacology is similar, their toxicology is similar and their use patterns are often quite similar. The regulatory schemes of EPA and FDA are quite different but each is thorough and demanding in its own way. Both agencies are doing an admirable job of registering products without approving fraudulent claims and dangerous products.

The continued problem with sulfamethazine tissue residues in swine was discussed from USDA, FDA and veterinary practitioners perspectives. Dr. Royce Harr of FSIS, USDA stated that the violation rate for
sulfamethazine residues has remained static for the last few years. An intensive residue testing program is being proposed by the USDA for further initiation in order to remove all sulfamethazine adulterated pig products from the marketplace. Dr. William Bixler of CVM, FDA identified several areas of concern, the most important of which involves the need for a swine identification system. Dr. Max Rodibaugh, a private swine practitioner representing the American Association of Swine Practitioners, stated that sulfa residue avoidance by swine producers must become a priority issue with them.

Dr. Bixler of CVM also discussed briefly the relatively high levels of animal drug misuse including underground importation, formulation and distribution of unapproved drug products. The agency is encouraged by the increasing awareness of the problems and the support for their discontinuation by a number of professional and industrial groups. While corrective and enforcement actions are complex and time consuming, the agency is becoming increasingly successful in punitive actions against flagrant violators.

Resolution No. USAHA Meeting
Held At: Louisville, KY Dates: October 19–24, 1986
Source: Committee on Pharmaceuticals, Pesticides and Related Toxicology
Subject Matter: Cattle Growth Implants

BACKGROUND INFORMATION
The European Community has voted to impose a ban on the use of growth implants on beef cattle raised by member countries; and
The EEC Scientific Working Group on Anabolic Agents does not support the ban because there is no scientific evidence that use of presently approved implants poses a threat to human health, and "enforceable ban will most probably result in a serious problem involving the illegal use of unlicensed hormonal products; and
The USAHA agrees with the findings of the EEC Scientific Working Group and is concerned that U. S. Cattle producers will be restricted from selling U. S. meat to EEC countries because of the ban.

RESOLUTION
BE IT RESOLVED that the USAHA strongly urge the USDA, the Office of Trade and Congress to take whatever actions are necessary to discourage the European Economic Community from implementing the restriction or ban on importation of meat derived from animals treated with animal drug implants approved by the U. S. Food and Drug Administration, where the restriction or banning is not based on sound scientific data.
REPORT OF THE COMMITTEE ON PROFESSIONAL OVERSIGHT

Chairman: Dr. P. L. Smith, Sacramento, CA
Vice Chairman: Dr. H. E. Goldstein, Columbus, OH

Dr. C. L. Campbell, FL; Dr. J. L. O’Harra, AZ; Mr. J. O. Pearce, Jr., FL;
Dr. J. R. Ragan, TN; Dr. D. U. Walker, VT; Dr. S. T. Wilson, Jr., MD.

USAHA Committee on Professional Oversight met 1:30 p.m. on Thursday, October 23, 1986, in Louisville, Kentucky. The committee has eight members of which seven were present.

At the 1985 meeting the committee recommended that APHIS clarify to state veterinarians how a proposed small animal health certificate was intended to be used. It was further recommended if this certificate is used for interstate shipment that copies be distributed in a manner compatible with the present procedures for large animal certificates. It was brought to the committee’s attention that the Southern Animal Health Group had expressed similar concerns. The committee was pleased to note APHIS has responded to the Southern Animal Health Group that the distribution procedures would be reviewed. The committee reemphasizes its 1985 recommendation and further draws attention to CFR mandate regarding pseudorabies health certification requirements which circumvent normal routing of these certificates through animal health official of the state of origin. It is recommended the CFR requirements be amended to provide for routing of health certifications in a manner compatible with long established procedures.

Dr. Steven Weber of the National Center for Animal Health Information System presented an overview of the BIS user group report. The BIS User Group Report prepared June 6, 1986, was distributed to all state livestock officials by APHIS on July 15, 1986. This report was reviewed by the Professional Oversight Committee because of the crowded agenda of the brucellosis committee and because the reports recommendations have the potential of expanding BIS to other official animal health programs.

Two resolutions pertaining to this report were approved and presented to the Resolutions Committee for consideration.

As a result of the discussion regarding the BIS User Group Report it was agreed that a broad spectrum group of technical expertise was needed to provide future advice on coordination of the development of data management systems that may be designed for animal health programs. This group could review and evaluate data management systems until they are developed to a point where they are considered satisfactory for adoption with specific disease programs. At this stage, the recommendations of the technical group would be referred to the appropriate standing committee for consideration.
REPORT OF THE COMMITTEE

The Professional Oversight Committee recommends that the President of the USAHA consider establishing an ad hoc Information Technology Committee to review data management systems and provide recommendations of the development of such systems.
REPORT OF THE COMMITTEE ON RABIES

Chairman: Dr. L. Russell, College Station, TX
Vice Chairman: Dr. W. R. Miller, Beltsville, MD

Dr. W. H. Beckenhauer, NE; Dr. R. R. Brown, AR; Dr. H. Draayer, IL; Dr. D. W. Dreesen, GA; Dr. T. J. Galvin, DC; Dr. B. B. Hancock, IA; Dr. D. R. Howard, KS; Dr. O. James, MT; Dr. B. Kaplan, KY; Dr. R. B. Miller, MD; Dr. J. C. New, TN; Dr. R. L. Sharpee, NE; Dr. J. M. Shuler, IN; Dr. A. Strating, TX; Dr. T. H. Woods, AR; Dr. J. C. Wright, AL.

The committee met on October 23, 1986, with 22 members and guests present.

OLD BUSINESS

1. The Management and Slaughter of Livestock Exposed to Rabies

   Because of the committee's concern about USDA, FSIS recommendations for management and slaughter of livestock exposed to rabies, a resolution was passed in 1985 asking that the USDA, FSIS, MPI to re-evaluate its current policy on the handling and slaughter of livestock exposed to rabies. No response has been received from the USDA. The committee recommended that last year's resolution and the lack of response be looked into by the chairman.

2. Immune Complex-Like Disease In Persons Following a Booster Dose of a Human Diploid Cell Rabies Vaccine.

   Dr. David Dreesen updated the committee on the current status of these reactions.
   a. The vaccine producer has added an adverse reaction statement to the package insert.
   b. The Advisory Committee on Immunization Practices, Public Health Service, has since recommended in place of a 2 year vaccine booster that a titer be determined and those people with greater than 1:5 do not need a booster.

3. Update on Animal Rabies Vaccines.

   Dr. R. B. Miller gave an update on animal vaccines including those approved for subcutaneous administration.

NEW BUSINESS

1. Communication from Dr. Jack Armstrong, Director, Division of Animal Industries, Department of Agriculture, Reno, Nevada.

   Dr. Armstrong expressed concern about the reliability of the skin biopsy technique for the diagnosis of rabies. After much discussion, a resolution was adopted.

2. Wildlife and Exotic Animals used as household pets.

   Dr. D. W. Dreesen, reported on some material concerning wildlife and
REPORT OF THE COMMITTEE

exotic animals, especially ferrets, used as household pets, that was presented in the Public Health and Environmental Quality Committee, USAHA. After discussion of concerns about the rabies potential of such animals, a resolution was adopted.

3. The Use of Strychnine in the Control of Rabies.

Dr. O. James presented some information on the use of strychnine as a tool to control rabies in skunks. After much discussion, the committee recommended further study on the subject and that papers be invited to discuss the control of skunk rabies at next year's meeting.


Dr. R. B. Miller broached the problem facing veterinarians and the USDA concerning the lack of scientific data on the protective values of rabies vaccines in wolves and wolf-dog crosses.

5. Rabies in Israel.

Dr. A. Shimshony, Veterinary Services, Ministry of Agriculture, Israel, gave a brief description of the rabies problem and control program in Israel.

6. Subject of Papers for next year's meeting.
   a. Population dynamics and rabies control.
   b. Effect of reducing skunk populations on the incidence of rabies.
   d. Genetically engineered wildlife rabies vaccines.

The meeting was adjourned.
The State Federal Relations Committee of the United States Animal Health Association held its annual meeting at the Federal Building in Hyattsville, Maryland, March 10-13, 1986. This committee met with representatives from Agricultural Research Service, Center for Veterinary Medicine, FDA, Food Safety and Inspection Service and Animal Plant Health Inspection Services. Veterinary Services gave presentations on their activities and programs.

Committee members were appreciative of responses to the various USAHA resolutions adopted at the USAHA meeting, October, 1985 in Milwaukee, Wisconsin. We expressed concern in some specific areas and they will be brought out in this report. This committee supports most of the program policy of USDA. Areas of agreement will not receive much attention in this report while areas of more concern will be presented in more detail.

USAHA is concerned by the lack of a contingency plan for funding of appropriate response in the event of an outbreak of exotic disease in the United States. USDA is urged to secure an agreement to provide necessary funding in the event of an animal health emergency.

The facility at Plum Island operated jointly by USDNAPHIS and USDNARS is the bulwark in the efforts of this nation to prevent the entry and establishment of exotic diseases of livestock. For full utilization of the potential of this facility, it is essential that both buildings and instrumentation represent the highest degree of sophistication funding can achieve.

The proposed expenditure of 8 million dollars in this effort is more than justified by the savings that would result in the prevention and control of the serious exotic diseases that could devastate the economy of the livestock industry. In the staffing of the facility every effort should be exerted to encourage and solidify a constant exchange of information between the staffs of APHIS-VS and ARS.

The USAHA recognizes the importance of the veterinary practitioner in animal disease control programs and supports APHIS-VS efforts to provide training and supervision necessary to maintain competent and reliable regulatory service from accredited veterinarians. Veterinary Services provisions for professional development of inhouse staff should be made available (as much as possible) to state regulatory staff and accredited veterinarians toward this end.

This committee also wishes to reiterate its recommendation regarding the advisability of relocating regional Veterinary Services offices in Hyattsville.
REPORT OF THE COMMITTEE

Future success in the control of disease lies in the rapid development of biotechnology. USDA must solve the present difficulties reported in deciding the staffing required by both research and regulation. An ongoing dialogue between APHIS, ARS, EPA, FDA and Administration scientific and technical staffs must be encouraged to meet the problems of biotechnology relevant to animal disease as they arise. If this is not encouraged, serious problems may arise which could impede development due to inability to allay the fears of groups outside of the scientific community who oppose the advancement and utilization of new technologies.

CENTER FOR VETERINARY MEDICINE, FDA

USAHA, through various committees, has requested for several years extra label approval of certain animal drugs especially for use in minor species. The committee requests that C.V.M. seek authority to continue present policy of accepting reasonable data to expedite use of effective and beneficial products where acceptable alternatives are unavailable. We support the definition of the Veterinary/Patient/Client Relationship in control of prescription drugs as put forth by A.V.M.A.

FOOD SAFETY AND INSPECTION SERVICE

This committee is vitally concerned with the funding of federal and state meat inspection programs. The consuming public of this nation has long depended upon this mandated program to provide assurance of a wholesome unadulterated product, produced in a clean sanitary facility.

The user fee concept reverses the position that the inspection program is totally a consumer protection effort and changes the role of meat industry management when plant management pays for the service.

State and Federal regulatory officials depend upon meat inspection for surveillance in brucellosis, tuberculosis and pseudorabies programs. This committee foresees a real problem if plant management would not participate in providing the existing service.

The user fee concept of funding meat inspection may well work for large volume Meat and Poultry Plants, but likely would cause the closure of many small plants presently inspected by state programs. If determined that a user fee system is necessary, then this committee urges MPIS to design a system to allow small plants to continue operation and to keep in place existing State Meat Inspection Programs.

AGRICULTURAL RESEARCH SERVICE

We commend ARS for their continued excellent research and progress on many projects such as heartwater disease.

The committee supports continued research in regards to pseudorabies and Avian Influenza.
STATE FEDERAL RELATIONS

Since biotechnology is of increasingly urgent importance, this committee feels ARS & APHIS need to deal aggressively with these issues.

We strongly encourage ARS & APHIS to move ahead on its FAO, Expert Associate Program in cooperation with the Agency for International Development (AID).

More research is needed on the development of vaccines for Paratuberculosis and Trichinosis. We urge continued research to develop diagnostic tests, antigens and other reagents for use in conducting tests for the diagnosis of Paratuberculosis and to approve laboratories to conduct test for diagnosis of Paratuberculosis.

VETERINARY SERVICES

There were a number of presentations by veterinary services for which this committee expresses concern or support. These items are of significance to the livestock and poultry industries and the veterinary profession:

1) The committee urges funds to be restored in the budget for the PRV program to enforce interstate movement and continue to work with the industry in developing a control program.

2) APHIS should continue efforts to study the feasibility of moving the screwworm barrier zone through Panama.

3) The committee supports fully the efforts of Veterinary Services working cooperatively with A.V.M.A. to increase the training of veterinary students in all of the veterinary schools and the development of new standards for accreditation and reaccreditation.

4) We support the program and the applicable compliance efforts to aid in the control of fraudulent blood sampling.

5) The privatization of quarantine stations is opposed by this committee. We believe this responsibility needs to stay in APHIS.

6) The committee does not support the transfer of animal welfare and horse protection responsibilities to the states or private agencies.

7) NVSL is commended for providing necessary laboratory support in emergency situations such as vesicular stomatitis and avian influenza. The regular support of state laboratories through supplying of reagents, check tests and training is also commended.

8) We suggest the NADDS program not be expanded too rapidly until problems in the pilot states are resolved. We support the concept of the program.

9) We are concerned that exotic birds pose a continued threat of VVND to the poultry industry. It is strongly recommended that APHIS initiate a program to require licensing of pet bird dealers who deal interstate with requirements for bird identification and record
REPORT OF THE COMMITTEE

keeping necessary for tracing bird purchases and sales. Stronger efforts should be made to stop smuggling of exotic birds.

10) We urge APHIS to initiate a study on the interstate movement of live poultry as it relates to potential spread of poultry diseases such as Avian Influenza.
REPORT OF THE COMMITTEE ON TRANSMISSIBLE DISEASES OF SWINE

Chairman: Dr. J. P. Kluge, Ames, IA
Vice Chairman: Dr. D. G. Thawley, Columbia, MO

Dr. G. W. Beran, IA; Dr. L. G. Biehl, IL; Mr. N. Black, MN; Dr. C. E. Boyd, SC; Mr. P. E. Bradshaw, IL; Dr. J. Castaneda, G., SA; Dr. A. M. Creswell, TN; Dr. P. B. Doby, IL; Dr. J. A. Downard, IN; Dr. G. A. Erickson, IA; Dr. A. M. Gallina, WA; Dr. D. P. Gustafson, IN; Dr. R. E. Hall, WI; Dr. D. L. Harris, MO; Dr. G. W. Hausman, IA; Dr. H. T. Hill, IA; Dr. W. L. Kadel, KY; Dr. C. L. Kanitz, IN; Dr. M. H. Lang, IA; Mr. N. Lichtman, NJ; Dr. V. Marshall, NE; Dr. J. W. McVicar, NY; Dr. P. A. O'Berry, IA; Mr. C. Rogers, NE; Dr. L. Schlater, IA; Dr. G. M. Schloer, NY; Dr. L. W. Schnurrenberger, MD; Dr. R. Schultz, IA; Dr. W. C. Stewart, MD; Dr. D. L. Thompson, CA; Dr. R. E. Thompson, NM; Dr. H. W. Towers, Jr., DE; Dr. M. W. Vorhies, SD; Dr. F. Wertman, IA; Dr. J. C. Wright, AL.

The Transmissible Diseases of Swine Committee met from 1:30–5:00 p.m. on Wednesday, October 22, 1986. Fifteen (15) committee members and 45 guests were in attendance.

The theme of the meeting centered around the emerging swine respiratory diseases. Dr. Richard Ross, Iowa State University, presented an overview of mycoplasmal pneumonia in swine and discussed the pneumonic syndromes which result when mycoplasmal disease is combined with other pathogens.

Dr. Wayne Freeze, practitioner from Worthington, Minnesota, provided an update on Streptococcus suis infection in swine. He noted that in his practice the two largest health problems in nursery pigs are scours and Streptococcus suis infections. Although pneumonia is only one of the syndromes produced by Streptococcus suis infection, the disease is increasing in incidence and becoming a year round problem in larger confinement operations.

Dr. Carlos Pijoan, University of Minnesota, discussed issues regarding the increasing incidence of Hemophilus and Pasteurella pneumonia in swine. He noted that more research is needed to further elaborate the pathogenicity of the diseases and to develop more effective means of control.

Dr. John Kluge, Iowa State University, reviewed European experience with pneumotropic strains of Aujeszky's disease virus (pseudorabies). He pointed out that the United States now has viral strains that cause similar lower respiratory tract disease. These viral strains are genetically unique and can cause severe losses from both mortality as well as major losses in rate of gain especially when combined with other bacterial pathogens.

The committee passed a resolution supporting a model state regulation for control of zoological animals that includes feral swine in the definition of zoological animal.
REPORT OF THE COMMITTEE ON WILDLIFE DISEASES

Chairman: Dr. E. T. Thorne, Laramie, WY
Vice Chairman: Dr. V. F. Nettles, Athens, GA

Dr. W. D. Bolton, VT; Dr. W. W. Buisch, MD; Dr. D. R. Cassidy, IA; Dr. A. H. Derdiri, NY; Dr. P. M. Eppele, MN; Dr. G. A. Erickson, IA; Dr. M. A. Essey, MD; Dr. D. P. Ferlicka, MT; Ms. A. M. Finley, TX; Mr. J. B. Finley, TX; Dr. E. E. Grass, MD; Dr. A. E. Hall, MD; Dr. F. A. Hayes, GA; Dr. B. R. Hillman, ID; Dr. D. A. Jessup, CA; Dr. D. C. Johnson, GA; Dr. W. E. Ketter, MD; Dr. R. J. Lee, VA; Dr. W. S. Lum, HI; Dr. H. A. McDaniel, MD; Dr. M. S. Silberman, GA; Dr. James S. Smith, MD; Dr. R. K. Stroud, WI; Dr. C. D. Stumpff, KS; Dr. A. B. Thiermann, IA.

The Committee on Wildlife Diseases met at 1:30 PM on Monday, October 20, 1986. Nine members and approximately 20 guests were present. The Committee's work for the past year was reviewed and new activities were planned for several items on the agenda. Summary statements of the Committee's recommended action are cited as follows:

1. Model Regulations for Control of Livestock and Poultry Diseases in Zoological Animals

Last year the Wildlife Disease Committee recommended that a Model Regulation be developed for state governments to use in the control of livestock and poultry diseases that could be harbored or spread by zoological animals. The Committee prepared a resolution that asked APHIS, USDA, to take the lead in developing this Model Regulation. Through a Cooperative Agreement, APHIS enlisted the help of the Southeastern Cooperative Wildlife Disease Study (SCWDS), College of Veterinary Medicine, The University of Georgia, to evaluate the current situation and prepare a draft of a Model State Regulation. Mr. P. M. Swiderek of SCWDS reported to the Committee on recent observations on zoological animal auctions and the status of the draft Model State Regulation. A summary of progress to date will be submitted for the record as an addendum to this Committee's report.

Upon hearing Mr. Swiderek's report and the resultant discussion, it was concluded that commercial trade in zoological animals and the resultant interstate travel do provide a mechanism for disease dissemination that is not sufficiently addressed by state or federal regulations. In addition to disease considerations, the current status of zoological animal trade has prompted concern from animal welfare groups and conservationists. The release or escape of exotic animals into the wild has become a major worry to state fish and wildlife agencies.

The Committee was presented with a draft copy of the Model State Regulation that addresses ownership, sale, transportation, and release of zoological animals. In formulating this working copy, numerous facets including disease prevention, public safety, environmental pro-
WILDLIFE DISEASES

tection, and animal welfare were considered. The State Department of Natural Resources has been given primary responsibility for permitting and licensing of zoological animals; however, cooperation among State Departments of Natural Resources, Agriculture, and Public Health will be vital in formulation of this regulation. Mr. Swiderek indicated he had been requested by APHIS, USDA, to present the draft Model State Regulation to the Wildlife Diseases Committee and several other groups within the USAHA for their review.

The draft Model State Regulation contained substantial detail and it was not feasible to review it during the Committee Meeting. However, the Wildlife Diseases Committee did agree with the general approach and the key elements of the Model State Regulation as summarized by Mr. Swiderek. A summary of the need for the Model State Regulation and its basic elements accompanies this report.

**Recommended Action:**

The Committee commends APHIS and SCWDS for their efforts in regard to the preparation of the much needed Model State Regulation. A Subcommittee within the Wildlife Diseases Committee was formed to review the draft Model State Regulation. This activity will be accomplished in the next month so that a revision can be made by the winter of 1987.

2. **Summary of the Yellowstone National Park Brucellosis Situation**

During the past year, several members of the Committee expressed concern about the presence of brucellosis in wildlife in Yellowstone National Park and its ramifications to the National Brucellosis Eradication Program. Dr. Don P. Ferlicka, State Veterinarian, Montana, summarized the history of the disease in the Park and presented a resolution regarding the matter for Committee consideration.

Since 1917, definitive evidence has been gathered that bison and elk resident to Yellowstone National Park are affected with *Brucella abortus* biovar I infection. The large populations of these two species inhabiting the Park perpetuate the infection and create important reservoirs of this organism. Current National Park Service policy for management of elk and bison is resulting in growth of populations of both these species. This in turn corresponds to an increased propensity of infected animals to emigrate out of Yellowstone National Park into the Brucellosis "Free" States of Montana and Wyoming and the Class "A" State of Idaho. Park administration rejects the eradication of brucellosis on Park premises by test and slaughter techniques and offers "separation" from cattle through boundary control as a solution. In years of heavy emigration of bison the issue of boundary control through dispatch of animals erupts into a very visible public controversy. The Park administration denies any importance of the disease to the well-being of Park wildlife. State and Federal livestock health officials continue to study
REPORT OF THE COMMITTEE

the problem and negotiate with Park personnel to effect a more definitive solution than boundary control through the implementation of a unique program of brucellosis control applicable to the circumstances of Yellowstone National Park.

Recommended Action:
The USAHA should encourage active cooperation between U.S. Department of Agriculture, APHIS, Veterinary Services and the Department of Interior, N.P.S., Yellowstone National Park to develop methods to contain and eliminate the reservoir of brucellosis that exists in the Park. A resolution to that effect was approved by the Committee.

3. Guidelines for Handling the Typical Small Outbreak of Duck Plague

During the past year, several isolated duck die-offs have occurred due to the viral disease, duck plague. This disease has the potential to inflict heavy losses in migratory waterfowl as demonstrated by the deaths of 40,000 birds on Lake Andes National Wildlife Refuge in 1973. However, the typical duck plague outbreak has been much smaller in scope with deaths in the low hundreds at most.

In spite of their small size, these duck plague die-offs must be reckoned with to stop the potential for virus spread to greater numbers of waterfowl. As noted by the Wildlife Diseases Committee last year, procedures for reacting to the typical duck plague infections have not been standardized and guidelines are badly needed. Personnel within the U.S. Fish and Wildlife Service were contacted for input in the form of draft guidelines on handling duck plague outbreaks. Dr. J. C. Franson brought a draft written by his agency which at the current time is being passed through approval channels in the Fish and Wildlife Service.

Recommended Action:
Copies of the draft guidelines should be reviewed by the Committee before any further action is taken.

4. Avian Influenza Update

An account of recent events associated with avian influenza in poultry was given to the Committee. Dr. A. E. Hall of Emergency Programs, Veterinary Services, APHIS, USDA, reviewed the recent history of H5N2 avian influenza infections in live poultry markets in the northeastern United States and south Florida. Concern was expressed because there was potential for pen-reared upland game birds to become exposed via the intricate marketing web that includes chicken, turkey, guinea fowl, pheasants, chukars, domestic ducks and geese, etc. The distinction between game birds destined for the table through live bird markets and game birds being propagated for shooting may be seasonal and dependent only on the relative profit available to the propagators. Given the complexity of the market system for live bird
sales, the possibility that some groups of hunting preserve birds have been exposed cannot be dismissed.

Dr. V. F. Nettles reported that he had notified the International Association of Fish and Wildlife Agencies of these concerns through a memorandum in April, 1986. Wildlife agencies were advised to do the following:

1. Contact their corresponding state animal health officials to discuss each agency's area of authority and how it would be applied upon discovery of avian influenza in game birds.
2. Provide animal health authorities with current lists of permittees who might have game birds in order to facilitate any surveillance effort.
3. Test agency-owned gallinaceous game birds for influenza prior to release and require tests on such birds released by others on public lands.

Until the recent infections in the live poultry markets developed, the position of regulating officials was that all H5N2 avian influenza viruses should be eradicated. A newly proposed position has been formulated by the USDA's Avian Influenza Technical Collaborating Committee which specifies that only avian influenza viruses that are capable of producing fowl plague-like disease in penned birds or are potentially pathogenic to chickens would be eliminated. The plan calls for no eradication action due to the discovery of lethal or non-lethal avian influenza viruses in wild birds.

Recommended Action:
None required. The Committee members were pleased with the section in the proposed position by USDA in regard to avian influenza in wild birds since it reinforces the concept that migratory waterfowl will be an uncontrollable source of influenza viruses and that poultrymen must accept the responsibility to protect their flocks through biosecurity and preventive medicine.

5. Disease Testing of Wild Turkeys Intended for Translocation

In the past few years, many State Fish and Wildlife Agencies have initiated serologic testing for mycoplasmosis in wild turkeys that are used for relocation. Mycoplasmosis is a significant disease for domestic poultry, and there is concern from both wildlife biologists and poultry health officials that introduction of this bacterial agent into wild turkey populations could lead to either sickness or a silent carrier status.

Wildlife officials have suggested that data derived from these monitoring efforts could be accumulated at a central access point for all conservation agencies. In this regard, the National Wild Turkey Federation was asked by the International Association of Fish and Wildlife
REPORT OF THE COMMITTEE

Agencies (IAFWA) if it would serve as a data bank. This organization was a logical choice since the Federation focuses on wild turkeys and has well-organized channels of communication with all persons involved in disease monitoring.

At the IAFWA meeting in September in Providence, Rhode Island, the mechanics of disease reporting were discussed. A draft of a questionnaire was written for use by the National Wild Turkey Federation. The Federation mailed the questionnaire on October 6, 1986, to all state biologists involved in wild turkey restoration. Several responses have already been received and many more replies are anticipated.

Recommended Action:

The USAHA should commend the actions of the IAFWA and the National Wild Turkey Federation in regard to *Mycoplasma* surveillance in wild turkeys. State Agriculture Agency members of USAHA undoubtedly have many laboratories assisting State Fish and Wildlife Agencies in testing the turkeys in question, and these laboratories should be encouraged to participate in data accumulation effort. Members of the Wildlife Diseases Committee of the USAHA should maintain contact with the National Wild Turkey Federation and report back next year on the results of their survey.

6. Expanded Use of the National Poultry Improvement Plan for Game Birds

During the last two years, occurrences of poultry diseases in pen-raised game birds have included pullorum (UT), *Mycoplasma gallisepticum* (SC), and H5N2 subtype avian influenza (OR). The potential for diseased pen-raised game birds to contaminate other phases of the poultry industry or populations of bona fide wild birds is a matter of mutual concern for agricultural and wildlife interests. Last year, Dr. I. L. Peterson, APHIS, Veterinary Services, explained to the Committee that assistance in disease prevention is available to game bird propagators in a cooperative state/federal program known as the National Poultry Improvement Plan (NPIP). The Wildlife Diseases Committee recommended that State Fish and Wildlife Agencies be apprised by the USDA of game bird breeders currently enrolled in the NPIP and that the USAHA should support State Fish and Wildlife Agencies in stipulating that pen-reared birds should meet NPIP standards. Contact between the IAFWA and the USDA was made recently through the Fish and Wildlife Health Committee of IAFWA. Dr. Peterson attended the IAFWA meeting in Providence, Rhode Island, and there was considerable discussion on the possibility that state regulations could be developed to stipulate that only NPIP birds could be released for hunting purposes. Included in the discussion was concern for the potential impact such regulations would have on the game bird and shooting preserve industries. IAFWA authorized their Fish and Wildlife Health
Committee to contact national organizations associated with the game bird industry and seek support for greater use of the NPIP.

**Recommended Action:**

The USAHA also should enjoin with IAFWA in their efforts to increase disease awareness among game bird propagators and shooting preserve operators. A resolution was prepared by the Committee which could be used by the USAHA to convey its stance favoring the requirement that pen-raised game birds being released for hunting or stocking purposes meet NPIP standards.

**SUMMARY ON THE NEED FOR A MODEL STATE REGULATION FOR CONTROL OF ZOOLOGICAL ANIMALS**

**Introduction**

Zoological animals can be broadly defined as recently captured native and nonnative (exotic) wild animals, native and nonnative wild animals raised in captivity, and wild forms of domesticated species. Conventional domesticated animals and some laboratory-adapted strains of wild animals are not included in this definition. During recent years, increased trade in zoological animals, and hence an increase in interstate movement, has magnified the potential for disease dissemination. Past experiences with tuberculosis in bison and elk, exotic Newcastle disease in pet birds, lethal avian influenza in fancy poultry and game birds, and foreign ticks on imported rhinoceroses have caused livestock and poultry health officials considerable anxiety. In addition, zoological animals may present problems relative to environmental damage, crop depredation, public safety, and animal welfare.

Primarily because of disease ramifications, the United States Animal Health Association (USAHA) formally requested that the Animal and Plant Health Inspection Service (APHIS), United States Department of Agriculture (USDA), investigate the trade in zoological animals and consider the development of a Model State Regulation for Control of Zoological Animals. Through a Cooperative Agreement, APHIS enlisted the help of the Southeastern Cooperative Wildlife Disease Study (SCWDS), College of Veterinary Medicine, The University of Georgia, to evaluate the current situation and prepare a draft of a Model State Regulation.

**Trade In Zoological Animals**

Much of the trade in zoological animals is done through the format of consignment sales at animal auctions which are held 15 to 20 times a year throughout the United States. At the request of APHIS, visits to auctions were made by SCWDS personnel to evaluate the zoological animal industry. In addition, a survey of existing regulations from selected state and federal agencies was conducted to clarify the legal basis for control of zoological animals.
During October 1985, three zoological animal auctions were attended in Ohio, Missouri and Texas. About 500 animals were present at the smallest auction and over 4,000 at the largest. Approximately 75 species of mammals, 100 species of birds, and 3 species of reptiles were recorded at one or more of the auctions. Major types of animals, in descending magnitude, were hoofed stock (mostly deer, African and Indian antelope, sheep, and goats); birds (mostly psittacines, fancy chickens, exotic pheasants, and ducks); carnivores (mostly small species such as mink, ferrets, and foxes); and primates. Sicilian donkeys, miniature horses, longhorn cattle, and various crosses of African and other standard breeds of cattle also were sold.

A variety of people attended the auctions, and it was apparent that the zoological animal industry is diverse and includes zoos, animal breeders, animal dealers, pet owners, animal hobbyists, hunting preserves, drive-through animal parks, circuses, etc. About 2,000 people from 40 states and 3 foreign countries attended the largest auction.

From these investigations, it was concluded that zoological animal auctions provide the mechanism for the assembly of thousands of animals representing hundreds of species. On-site observations revealed that native animals, nonnative animals, and domestic animals came in direct and indirect contact with each other and then were dispersed to as many as 30 or 40 states. Although records of buyers and sellers were kept, many species of animals not permanently identified and epidemiological tracebacks would be difficult or impossible.

It was also disturbing to learn that existing regulations concerning ownership, sale, and transportation of zoological animals are generally inadequate and are fragmented among 50 State Agricultural Agencies, 50 State Departments of Natural Resources, the USDA, and the U.S. Department of the Interior. At the auctions visited, the only consistent disease control regulations were the requirements of a general health certificate for all out-of-state animals and tuberculosis/brucellosis tests for bison.

From these findings, it was concluded that a Model State Regulation to control ownership, sale, transportation, and release of zoological animals would indeed be useful as guideline for states that wish to upgrade their current regulations where deficiencies exist.

The Draft Model State Regulation

A draft copy of the Model State Regulation has been prepared that addresses ownership, sale, transportation, and release of zoological animals. In formulating this working copy, numerous facets including disease prevention, public safety, environmental protection, and animal welfare were considered. The State Department of Natural Resources has been given primary responsibility for permitting and licensing of zoological animals; however, cooperation among State Departments of Natural Re-
sources, Agriculture, and Public Health will be vital in formulation of this regulation. The current draft Model State Regulation contains the following elements:

1. A statement of mutual intent among the State Departments of Natural Resources, Agriculture, and Public Health that it is in the public interest to regulate zoological animals.

2. A definition of zoological animals and a list of those species not considered zoological animals.

3. A provision that jurisdiction over native wild animals would remain with the State Department of Natural Resources. However the State Departments of Agriculture and Public Health could make recommendations concerning ownership, sale, transportation, and release of these animals.

4. A provision that the State Department of Natural Resources would have jurisdiction over nonnative wild animals. However the State Departments of Agriculture and Public Health would have power to independently prohibit the ownership, sale, transportation, and release of these animals if adverse consequences were likely to occur in their areas of concern.

5. An arrangement whereby the Director of the State Department of Natural Resources would assemble a regulations board to determine requirements for ownership, sale, transportation, and release of zoological animals for the state in question. Voting membership of the Regulations Board would include representatives from the State Departments of Natural Resources, Agriculture, and Public Health. Applicable interest groups would be represented in an advisory capacity on the Regulations Board. The Regulations Board would categorize zoological animals as Class I (prohibited species), Class II (species requiring permits or licenses), and Class III (unregulated species). A classification list is provided in the draft Model State Regulation.

6. A classification system for various permits and licenses for zoological animals including the following: personal possession; animal dealer; commercial exhibition; non-profit exhibition; hunting preserve; rehabilitation; scientific research; falconry; and importation. All permits and licenses except importation would be issued solely by the State Department of Natural Resources.

7. A provision whereby zoological animals entering the state in question for ownership, sale, display, or release would be required to have a permit issued by the State Department of Natural Resources. Two exceptions to this provision would be pen-raised game birds and pet birds, which would be permitted for importation by the State Department of Agriculture.
REPORT OF THE COMMITTEE

8. A set of guidelines for health certificates and specific disease testing to be required for zoological animals being imported under permit. Primates and ungulates must have a negative tuberculosis test prior to interstate shipment. In addition, ruminants and wild swine must have a negative brucellosis test, and hartebeests and wildebeests must have a negative malignant catarrhal fever test. Pen-raised game birds destined for interstate shipment would be required to meet the standards of the National Poultry Improvement Plan for infectious diseases.

9. A set of standards for the humane handling, care, confinement, and transportation of zoological animals to address all species, including many situations not currently regulated by the Federal Animal Welfare Act.

REVIEW OF THE DRAFT MODEL STATE REGULATION

Copies of the draft Model State Regulation were submitted to Veterinary Services, APHIS, USDA on October 7, 1986, for review. At that time, APHIS officials requested that the Model State Regulation also be made available for review to interested committees within the USAHA at the Annual Meeting in Louisville, Kentucky. In addition, instructions were given to submit copies of the draft Model State Regulation to organizations outside the USAHA that should be involved in the initial review, particularly the International Association of Fish and Wildlife Agencies (IAFWA) and the National Association of State Public Health Veterinarians (NASPHV).

Comments and suggestions from all reviewers will be considered in the revised draft which should be accomplished by early 1987. It is anticipated that the revised draft Model State Regulation will be offered for endorsement to the USAHA, IAFWA, and NASPHV. An endorsed Model State Regulation would then be distributed to State Departments of Natural Resources, Agriculture, and Public Health for their use.
REPORT OF THE COMMITTEE ON
ZOOCASEICAL ANIMALS

Chairman: Dr. M. S. Silberman, Atlanta, GA
Vice Chairman: Dr. R. L. Crawford, Hyattsville, MD

Dr. L. H. Cornell, CA; Dr. P. M. Eppele, MN; Dr. G. A. Erickson, IA; Dr. J. A. Farrar, GA; Dr. M. Friend, WI; Dr. A. A. Furr, MD; Dr. D. E. Herrick, MD; Dr. W. P. Heuschele, CA; Dr. C. W. S. Lum, HI; Dr. C. J. Mikel, OK; Dr. G. W. Patterson, TN; Dr. J. B. Payeur, TX; Dr. G. P. Pierson, MD; Ms. J. Roush, DC; Dr. K. C. Sherman, MO; Dr. E. T. Thorne, WY; Dr. R. J. Yedloutschnig, NY.

Visitors: Dr. J. A. Breuggman, FL; Dr. Wilbur Amand, PA; Mr. Gerald Lentz, FL; Ms. Ann Gonnerman, MO; Dr. R. R. Bowen, NE; Dr. H. T. Scott, Canada; Dr. C. G. Caffey, MD; Dr. Sam Richeson, MD; Mr. Nels Konnerleys, WA; Dr. Dale Schwindaman, MD; Dr. Harold E. McCoy, IL; Ms. Barbara Hoferman, DC; Dr. Harvey Keydew, MA.

The chairman called the meeting to order at 1:30 p.m. on October 20, 1986. There were 21 members and guests present.

Dr. W. Heuschele offered a resolution that would allow for the importation of exotic ruminants that had serological titers for rinderpest. He referred to a number of references that suggest that the existence of a persistent latent rinderpest virus does not exist. Evidence was also introduced that indicated that live rinderpest virus does not persist outside of the body. Dr. C. W. S. Lum seconded the motion to adopt this resolution and discussion was opened to the membership.

Dr. D. Herrick stated that there would have to be a consensus between APHIS and ARS to resolve this favorably. A request would have to be made to the Plum Island staff to seek support of the evidence presented.

Dr. W. Heuschele cited 200 years of recorded quarantine procedures with no evidence of rinderpest transmission. He also reviewed the pressing need to attempt to save species that are on the verge of extinction if not removed from the areas that they currently are found because of the severe devastation of their habitat. There was no question that immediate action must be taken if some of the species are to survive.

The Chairman suggested that the resolution be modified to ask the Plum Island staff to expedite a decision on this matter because of the urgency cited.

Dr. R. Yedloutschnig stated that there are variant strains that may give different test results.

Dr. K. Sherman asked if we tested animals coming from Canada and Europe for rinderpest. The answer was no for Canada and yes for Europe. The Chairman asked if virus isolation studies could be done on rinderpest positive animals to establish these animals as being free of the agent. Dr.
R. Yedloutschnig said this would be possible and detailed some of the steps that would have to be followed. It was also pointed out that if a requirement for rinderpest testing be discontinued the law would not have to be changed. Dr. C. W. S. Lum asked that the resolution be left intact. The Chair called for a vote and the resolution carried.

Dr. D. Herrick briefly reviewed the guidelines for importation of exotic animal embryos and the cooperative agreement being worked out to assist a group in carrying out a related project. Dr. W. Amand stated that AAZPA backs this position and is looking forward to its inception.

The Chair questioned whether or not embryo transfer might not be a solution for some of the problems discussed during the rinderpest critique. Dr. Heuschele pointed out the lack of knowledge about reproductive physiology in most of the severely endangered species which would make this unfeasible.

The Chair asked Dr. D. Herrick to bring us up to date on the Rotterdam quarantine station. He informed us that the animals would be shipped from Amsterdam, approximately 30 miles from the quarantine station. This presents a potentially serious problem if the route of transportation is through rural agricultural areas. It was further stated that the European agent for USDA would be asked to review this route and determine its suitability. As soon as this is completed a decision will be made.

A model State Regulations for the Control of Zoological Animals was presented to the committee for review and comment. The model was drawn by representatives of the Southeastern Cooperative Wildlife Disease Study at the request of APHIS. The Chair reviewed the need for such regulations and the prior history that led to SCWDS being asked to complete this project. The recent interest and growth of exotic animal auctions and the lack of viable controls for animals entering or leaving these events was a significant reason to move this project forward. Mr. Pete Swinderek of SCWDS presented the document. He summarized the highlights and asked for comments within 30 days by the committee. The Chair pointed out that 90 days would be more realistic and asked that individuals respond directly to SCWDS. The Chair also suggested that both AAZPA and AAZV review the document from an association standpoint and comment from their individual group.

A lively discussion followed and it was evident that there would be several opinions voiced on such things as definition for exotic animals, diseases to be tested for, including acceptable testing methods, and issues relating to animal welfare. It was also the suggestion of industry representatives that the term zoological animal be dropped. They feel that the connotation is unfair and puts zoos at a disadvantage and succinctly pointed out that there are far more exotic animals on ranches and entities like them than in all the zoological gardens. It was agreed to get comments to SCWDS within 90 days to give them time to revise the document. Upon
revision it will be submitted to the members and other interested parties with hope for a positive show of support at the 1987 meeting. If possible a mail ballot will be solicited.

The status of the post entry quarantine animals was discussed. It was stated that changes would be dependent on Congress changing the present law. A suggestion was made that if these changes would be important to the zoo industry that they solicit the support of the various livestock groups prior to setting these changes.

The meeting was closed at 4:30 p.m.
ECONOMICS OF DISEASE AND ITS EFFECT ON DISEASE SURVEILLANCE

Presented to USAHA General Meeting Oct. 1986
By Bob Bohlender, DVM

Every one of us deal with the economics of disease on a daily basis in one way or another. The national figures on disease losses are appalling and they don't even include the subclinical disease costs.

After the tremendous technological advances of the last few years we should have reduced disease much more than we have. The percentage loss seems to remain pretty much the same. In fact, in the last 10 years it has not changed except fewer livestock producers are left to assume the same total loss.

Some of the national figures on disease losses are startling and are almost too big to even really make sense to a Nebraska cowboy. Just to name a few from 1983–1984:

1) $14 Billion annual losses to disease
2) 20% loss of income for the animal production industry
3) Another 14–20% loss from reduced reproductive efficiency
4) Death loss of 1,880,000 cattle plus 3,621,000 calves
5) Death loss of 4,958,000 hogs
6) 682,000 dead sheep and 942,000 dead lambs
7) $300 to $750 million loss to respiratory disease with an estimated 50% of cattle under 1 yr. of age affected
8) $180 loss per dairy cow from mastitis
9) Reproductive disease losses in the cattle industry are over $1 billion annually
10) Sales of animal health products exceeds $2 billion

The United States does not have a national animal morbidity and mortality reporting system so the production efficiency losses are impossible to properly address. This is a very important factor as we attempt to justify research funding, educational funding, and regulatory funding.

The National Animal Disease Detection System that has been initiated within APHIS has the ability to address the problem of assessing clinical disease, subclinical disease and efficiency losses. The program name has been changed to National Animal Health Monitoring System (NAHMS). NAHMS can also assess our response to disease in general. In the long run this information on how we respond to disease will be very valuable to all of us.

One of the early pilot studies shows that the overt and excessive use of drugs without adequate supervision was not only expensive but completely ineffective in improving the economics of the operations.

We are in an era of consumer awareness and it is going to continue. The livestock industry cannot turn away from this issue. We use drugs to
control disease and as the levels of costly disease continue the industry will be placed in an uncomfortable position. National studies show that a high percent of the American consumers have concerns over red meat safety. Some surveys show as high as 80% of the consumers consider safety in their meat selection.

This then is a major factor in the economics of disease in the United States and the veterinary profession is going to have to address this issue right up front. As the cattle industry moves on this problem the producers creating their own problem will be found out. On the other hand those veterinarians who anywhere in the production and finishing fail to properly counsel their clients on proper drug selection and use will be doing their clients a great disservice.

The NCA membership has determined that beef safety is a high priority. A task force is working now to assess the issue and develop recommendations.

Management practices are changing rapidly in the livestock business today. In my experience the poor operator is gone, he has been out of business for several years. The disease losses now are often the result of production systems that did not exist a few years ago. Maximizing production with an increase of 150 pounds weaning weight, intensive crop production with fertilization, specialization with huge concentrations of animals, and alternate feed sources are only a few of the changes we see. During the recent economic problems in the cattle industry I have seen a marked reduction in manpower on most ranches. Their ability to handle disease problems is going to be jeopardized and there will be an increase in disease losses.

We have not stayed ahead of the livestock industry in the animal health needs. Our research needs are critical now and we will have to work harder to catch up to the pressing problem of disease loss. In order to enlarge or even maintain our research community during this period of austere budgets we will have to present our case better. The information that could assist us in this effort could be obtained thru the NAHMS program.

The success ratio of research grant applications that go to NIH is about 35% whereas it is below 16% with the animal health applications to CSRS programs. There just aren’t enough dollars put into research to help control a $14 Billion annual disease loss in the United States.

We need to develop more research into the predisposition factors of disease and how we can have adequate immune capabilities.

Another economic factor of disease is the disruption in marketing. 1.) Sick calves that can’t be sold to the neighbor. 2.) Brucellosis exposed cows that can’t be sold interstate. 3.) Animals, embryos, or semen that can’t be
BOHLENDER

sold in international commerce because of potential disease problems. These losses don’t appear in any of our existing data on disease.

I assure that the National Cattlemens Association is and will continue to work toward resolution of some of these problems that keep the costs of disease high in the United States.
NATIONAL ANIMAL HEALTH MONITORING SYSTEM
EVALUATION OF LIST FRAMES FOR DISEASE
SURVEILLANCE SAMPLING OF CALIFORNIA BEEF CATTLE
AND COMPARISON OF NAHMS PILOT PROJECT WITH
RETROSPECTIVE INTERVIEW DATA

Cyrus Danaye-Elmi, D.V.M., M.P.V.M., Ian A. Gardner, B.V.Sc.,
M.P.V.M., Ph.D., David W. Hird, D.V.M., M.P.V.M., Ph.D.,
William W. Utterback, D.V.M., M.P.V.M.

SUMMARY

We evaluated list frames of Tulare County, California beef breeding
cattle operations for disease surveillance sampling. Nine different sources
including Statistical Reporting Service (SRS), Animal Health Branch,
California Department of Food and Agriculture (AHB), and auction yards
(AUC YDS) were used to compile a composite master list frame. The SRS
list contained 46% of the herds on the composite master list and 48.8% of
the total breeding cattle, while AHB and AUC YDS lists included 38% and
52.4%; and 61% and 74% respectively. A total of 115 (86.4%) beef oper-
ations from the composite master list having fifty or more breeding cattle
participated in a survey in which we asked questions about presence of
disease, herd size, type of cattle (purebred or commercial breed), use of
veterinary services, number of animals culled due to reproductive prob-
lems, use of artificial insemination, presence of poisonous plants, and cost
of preventive measures.

Our survey indicated no significant differences among the three sources
for various disease rates, but the auction yard list seemed more represen-
tative and complete than the SRS and AHB list frames. Comparison of
results of this survey with data recorded during the first round of the
National Animal Health Monitoring System (NAHMS) in California
revealed that morbidity and mortality rates for various diseases were
higher, but estimates of cost of preventive measures were lower in this
survey than in NAHMS.

INTRODUCTION

One of the objectives of the National Animal Health Monitoring System
(NAHMS), formerly known as the National Animal Disease Detection
System (NADDS), is to secure, by means of sampling, valid statistical
estimates of disease prevalence, incidence, and economic costs. Since
1984, the California pilot program has developed a list frame methodology
to achieve its projected goals. Various sources have been evaluated to find a satisfactory listing (list frame) from which a valid sample could be drawn for disease surveillance of sheep and swine in California.

Lack of a comprehensive list frame for sampling often occurs because it is difficult and expensive to construct, maintain, and update lists of operations. The size and economic structure of the United States beef cattle industry makes it almost impossible to have a computerized herd health card for disease investigation or surveillance similar to the one in Norway.

In this study, we evaluated three list frames of beef breeding cattle operations in Tulare County, California. To compare list frames, we collected health and production data by interview from 115 herds. Estimates of morbidity and mortality rates and costs of disease prevention obtained by using each list were compared amongst themselves and with a composite master list frame. In addition, the results of these interviews were also compared with NAHMS pilot program data previously collected.

MATERIALS AND METHODS

Tulare County was selected for this study because of its many beef herds and the fact that 27% (4 of 15) of California NAHMS beef herds sampled during the first pilot project (July 1984 — September 1985) were located there. The presence of the Veterinary Medicine Teaching and Research Center (VMTRC) of the University of California, Davis, in Tulare County has made the beef industry receptive toward various research projects. A master list of 1070 potential beef herds was compiled from the following sources:

1. Statistical Reporting Service (SRS) 167 names
2. Auction Yard #1 360
3. Auction Yard #2 53
4. Auction Yard #3 47
5. Tulare County Farm Advisor (TCFA) 53
6. Tulare County Cattleman's Association (TCCA) 93
7. Pharmaceutical Company (Ph Co) 82
8. Practicing Veterinarians (PV) 36
9. California Animal Health Branch (AHB) 179

*Sources 2, 3, and 4 are collectively referred to as auction yards (AUC YDS) in the balance of the paper.

Local brand inspectors were consulted to eliminate duplicate names on the lists, e.g. businesses also listed as individuals, to identify out-of-business cattle operations, and to identify operations with 50 or more beef breeding cattle.

During July 1985, the owner or manager of each operation on the list was contacted by telephone to verify herd status (all herds must have had 50 or more beef breeding cattle to be included in our composite master list.
frame) and to arrange for in-person interview. The questionnaires used in personal interviews were mailed in advance to allow time to gather pertinent information.

Of the 115 completed interviews, all but five were conducted in person by the senior author and three were completed by telephone. Three knowledgeable cattle dealers and two local brand inspectors in Tulare County verified the completeness and accuracy of the list.

The questionnaire, which covered the period August 1, 1984 through July 31, 1985 included the same questions asked in the routine NAHMS pilot program questionnaire as well as additional questions. During the interview we asked the owner or manager questions about morbidity and case fatality rates (where appropriate) of seven different conditions: pneumonia, pinkeye, dystocia, neonatal enteritis, scours, abortion, and footrot. In contrast, in routine NAHMS interviews, the owner was asked to report any diseases present and was not prompted by naming diseases or conditions. In our survey, we also asked questions about type of cattle (purebred or commercial breed), herd size, use of veterinary services, diseases considered potential threats to the herds, preventive measures and their costs, common diseases treated, total number of animals culled, number of animals culled due to reproductive problems, use of artificial insemination, and presence of poisonous plants.

In the NAHMS pilot program, the California Animal Health Branch (AHB) list frame was used to select randomly four beef herds having fifty or more beef breeding cattle in Tulare County. For each of these four herds, the owner or his representative was interviewed once a month, from July 1984 to September 1985. Data for the last twelve months were analyzed (unpublished report, Department of Epidemiology and Preventive Medicine, University of California, Davis). In our study, all Tulare County beef breeding herds having fifty or more breeding cattle were interviewed only once, and the questionnaire covered a twelve month period from August 1, 1984 through July 1985. Data from these two methods of sampling were compared.

STATISTICAL ANALYSIS

Collected data were entered into a computer file and analyzed using BMDP statistical programs. Descriptive statistics were computed for the composite master list frame, t-tests were performed for the continuous variables of the three major list frames, and Chi-square tests were used for categorical variables. Comparisons were made between names appearing on a list and names not appearing on the same list, e.g. SRS and non-SRS, AUC YDS and non-AUC YDS, AHB and non-AHB. Each list was also compared with the composite master list. Box and whisker displays were used to demonstrate the herd size distribution of the composite master list and each list frame.
RESULTS

From the main list of 1070 names, brand inspectors generated a list of 332 potential beef cattle operations. After contacting the owner or manager by telephone and eliminating operations having less than fifty beef breeding cattle, the list was further reduced to 133 names. Eighteen (13.5%) of 133 owners declined to be interviewed: fourteen because of lack of time or unwillingness to answer questions concerning financial expenditure, and four for no stated reason. The number and proportion of beef cattle operations surveyed according to the list frame on which they appeared is shown in Table 1. The proportion of operations on each list that overlapped with one or more of other operations ranged from 72 to 100%. Of the 115 participating operations, six (5.2%) maintained health records which were used to answer our questions. The remaining operators (94.8%) answered questions by recollection.

The Statistical Reporting Service (SRS) list contained 46% of operations on the composite master list, and 48.8% of the total beef breeding cattle population. The Animal Health Branch (AHB) list contained 38% of the composite master list and 52.4% of the total beef breeding cattle population. The auction yard list (AUC YDS) contained 61% of operations and 73.8% of the cattle population of the total composite master list.

The distribution of herd sizes was similar for the three lists (figure 1). Median herd size was 183, 274, and 217 for SRS, AHB, and auction yard lists respectively and 173 for all herds (the composite master list). From August 1, 1984 to July 31, 1985, the total number of beef cattle in the 115 surveyed herds was: 21,224 cows, 1,187 bulls, 20,511 young stock, and 13,409 calves. No significant differences in mortality or morbidity rates were observed among the three different list frames (SRS, AHB, AUC YDS) when they were compared with each other or with the composite master list.

The proportion of operations recording diseases varied according to herd size. Fifty-one percent of small herds (50–199 head), 26% of medium herds (200–499 head), and 23% of large herds (500 or more head) recorded at least one disease. However, rates of disease in three different list frames (SRS, AHB, AUC YDS) were similar when compared with each other and with the composite master list. Table 2 presents comparisons among list frames of type of cattle, use of veterinary services, cows culled due to reproductive problems, use of artificial insemination, and problems with poisonous plants. No significant differences between SRS, AHB, and AUC YDS rates were observed (p > .05). It is important to note that 28 of 115 (24%) surveyed operations maintained some registered purebred cows or heifers. Purebred bulls were not taken into account because almost every operation either owned or used the services of a purebred bull. Thirty of 115 (26%) operations did not use the services of a veterinarian during the year; the remaining 74% used a veterinarian only to treat complicated...
NATIONAL ANIMAL HEALTH MONITORING SYSTEM

cases or to vaccinate against brucellosis once or twice a year. Thirty-six percent of cull cows were culled because of reproductive problems, while 7% were culled because of disease. Only 13 of 115 (11%) operations used artificial insemination. Although 31% of the surveyed operations recorded some kind of poisonous plants on their properties, poisonous plants were not reported to be a major problem except during drought or feed shortage on the range.

Participants were asked if they felt potentially threatened by any livestock disease. Fifty percent (50%) did not feel threatened at all. Twenty-six (26%) indicated trichomoniasis as the most threatening disease, 7% grass tetany, and 5% brucellosis. Fifty-seven percent of the surveyed herds were operated by the owners or their family members on a day-to-day basis while 11% of the herds were operated by hired persons. The remaining 32% of operations were operated by a combination of owner, family members, and hired persons.

Table 3 represents comparison of morbidity and mortality rates of six conditions by age class and two different methods of sampling: 1. the NAHMS pilot program data collected by interview of four randomly selected beef herds from Animal Health Branch list once a month for fifteen months (July 1984—September 1985) and 2. the present study in which owners of all 115 beef herds in Tulare County were interviewed only once.

Table 4 shows annual cause-specific morbidity and mortality rates for various conditions in the same four Tulare County herds interviewed by two different methods. Age-specific annual mortality rates per 1000 reported for the same four herds were:

<table>
<thead>
<tr>
<th>Condition</th>
<th>NAHMS pilot program</th>
<th>This study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calves</td>
<td>51.0</td>
<td>117.0</td>
</tr>
<tr>
<td>Young Stock</td>
<td>6.6</td>
<td>3.0</td>
</tr>
<tr>
<td>Cows</td>
<td>2.9</td>
<td>4.8</td>
</tr>
<tr>
<td>Bulls</td>
<td>2.4</td>
<td>21.0</td>
</tr>
</tbody>
</table>

Preventive measures were most commonly used against infectious bovine rhinotracheitis (IBR), bovine virus diarrhea (BVD), parainfluenza 3 (PI3), leptospirosis, clostridial diseases, brucellosis, and internal and external parasites. Cost of preventive measures included cost of vaccines, labor, and hiring a veterinarian when applicable. The mean estimated annual cost of preventive measures per head (adult equivalent $= 0.7 *Young Stock + 0.2 *Calves + Cows + Bulls) in this survey was $5.50, but an estimated of $9.60 per head was reported using the NAHMS method. The mean estimated annual cost of preventive measures per herd for four surveyed herds in Tulare County with NAHMS method was $6096 while this survey showed a mean preventive cost of $3508 for the same four herds, and $1469 as a mean preventive annual cost per herd when all 115 surveyed herds were taken into account.
DISCUSSION

Our survey did not show major differences in herd characteristics or morbidity and mortality rates among beef breeding cattle operations appearing on the three different major list frames (Statistical Reporting Service, Animal Health Branch, auction yards). Information gathered in our survey was based on recollection, and therefore different results might have been obtained if record keeping systems had been more widely used. Although there were no differences among the three different sources in disease recording patterns, small herds recorded proportionally more diseases than medium and large ones. The higher disease recording might be attributable to better recollection on the part of owners of small-sized herds.

Each of the three major lists used in our survey had advantages and disadvantages for use as a sampling list frame. Median herd size in the SRS list was closer to the median herd size of the composite master list frame than either of the other two lists (see Figure 1). However, the SRS lists may not be updated for several years and thus livestock inventories may be outdated. For example, out of 167 names or purported beef cattle operations obtained from the SRS list, 79 (46%) were not valid for our survey: 43 named operations had only dairy cattle, 24 operations did not have any beef cattle, and 12 operations could not be located.

The Animal Health Branch (AHB) list was also attractive as far as herd size distribution was concerned, but had two main disadvantages. First, this list had not been updated since its creation. Because 57 of 179 operations did not exist and 39 of 179 names had no cattle, 55% of the list was not usable. Second, this list was compiled mainly for brucellosis-related activities (calfhood vaccination 85%, brucellosis market cattle identification 9%, and brucellosis-infected herds 6%), and therefore it represented only those beef herds that come in contact with Animal Health Branch veterinarians for regulatory reasons. However, this list will become more valuable in the future with the advent of mandatory brucellosis calfhood vaccination of beef cattle in California.

The auction yard list had the best herd size distribution in comparison with the other two lists and contained 61% of the composite master list of operations and 74% of the total beef breeding cattle in Tulare County (Figure 2). The auction yard list also contained 23 names which did not appear on any other list. If this list was supplemented with any of the two other lists, it would have included between 70 and 73% of the names on the composite master list frame. In this list, only 12.6% of the named operations either could not be found (29 names) or had no cattle (29 names). Because of a better representation of all herds and breeding cattle (61 and 74% respectively), this list seemed the best list frame in our survey.

The NAHMS pilot program recorded lower morbidity and mortality rates for various diseases than those revealed in our survey. Also, cost of
diseases in the NAHMS pilot project was higher than this retrospective survey. The cost of preventive measures reported by one of four participating operations interviewed by NAHMS method was $19833. This same operation reported $8297 as cost of preventive measures for this survey. These differences could be the result of improper communication, or misinterpretation of the questions by two different interviewers during the interview. Also the herd size (this was a large herd) might be a major contributing factor. We believe discrepancies between these two methods of sampling may be due to several reasons. The format of the questionnaire used in the present study was designed to stimulate owners to remember morbidity, mortality, and associated costs by prompting them with a list of diseases or conditions and asking them if they had illness or death due to these diseases in the past twelve months. In the NAHMS method, however, prompting questions were not allowed. Also, the NAHMS pilot project Round 1 was in its experimental stage and different interviewers were involved in collecting the data, but in this retrospective survey almost all of the interviews were conducted by the senior author. With the NAHMS method, owners generally seemed to start the program enthusiastically, but enthusiasm declined rapidly without some kind of incentive to maintain their interest; the retrospective survey used in the present study was a one time interview only. However, the results for only one large operation varied greatly between the two interview methods, while three showed little variation. Hence this one large operation was responsible for the discrepancy between our survey results and the NAHMS results.

REFERENCES


ACKNOWLEDGMENTS

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Agriculture with data collection and analysis. We also thank R. Miller, University Cooperative Extension, Visalia and the many veterinarians, brand inspectors, cattlemen's associations, and auction yard personnel, who helped compile the master list of beef operations.

This study was supported in part by Cooperative Agreement 12-16-98-019, APHIS/USDA.

**Figure 1:** Box-and-whisker display (quartiles, median, and extremes) of herdsize distribution from three different sources, and the composite list for Tulare County beef cattle surveyed August 1984 – July 1985.

- a: California Animal Health Branch
- b: Statistical Reporting Service
- c: Auction yards
Figure 2: Number of herds in three herd size categories for three list frames and the composite master list in Tulare County, California.

a: California Animal Health Branch
b: Statistical Reporting Service
c: Auction yards
Table 1: Number and proportion of breeding beef cattle operations participating in Tulare County survey (August 1, 1984 – July 31, 1985) by list frame in which they appeared.

<table>
<thead>
<tr>
<th>List Frame</th>
<th>No. of Operations</th>
<th>On List Frame&lt;sup&gt;(1)&lt;/sup&gt;</th>
<th>With&lt;sup&gt;a&lt;/sup&gt; &gt;50 Breeders&lt;sup&gt;(2)&lt;/sup&gt;</th>
<th>Which&lt;sup&gt;b&lt;/sup&gt; Participated&lt;sup&gt;(3)&lt;/sup&gt;</th>
<th>Overlapped&lt;sup&gt;c&lt;/sup&gt; Other Lists&lt;sup&gt;(4)&lt;/sup&gt;</th>
<th>Exclusively&lt;sup&gt;d&lt;/sup&gt; On List&lt;sup&gt;(5)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>California Animal Health Branch</td>
<td>179</td>
<td>51&lt;sup&gt;(28%)&lt;/sup&gt;</td>
<td>44&lt;sup&gt;(86%)&lt;/sup&gt;</td>
<td>35&lt;sup&gt;(80%)&lt;/sup&gt;</td>
<td>9&lt;sup&gt;(20%)&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Practicing Veterinarians</td>
<td>36</td>
<td>23&lt;sup&gt;(64%)&lt;/sup&gt;</td>
<td>21&lt;sup&gt;(91%)&lt;/sup&gt;</td>
<td>19&lt;sup&gt;(90%)&lt;/sup&gt;</td>
<td>2&lt;sup&gt;(10%)&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Pharmaceutical Company</td>
<td>82</td>
<td>31&lt;sup&gt;(38%)&lt;/sup&gt;</td>
<td>25&lt;sup&gt;(81%)&lt;/sup&gt;</td>
<td>25&lt;sup&gt;(100%)&lt;/sup&gt;</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Auction Yards</td>
<td>460</td>
<td>95&lt;sup&gt;(21%)&lt;/sup&gt;</td>
<td>81&lt;sup&gt;(85%)&lt;/sup&gt;</td>
<td>58&lt;sup&gt;(72%)&lt;/sup&gt;</td>
<td>23&lt;sup&gt;(28%)&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Tulare Co. Cattleman Ass'n</td>
<td>93</td>
<td>33&lt;sup&gt;(35%)&lt;/sup&gt;</td>
<td>29&lt;sup&gt;(88%)&lt;/sup&gt;</td>
<td>23&lt;sup&gt;(79%)&lt;/sup&gt;</td>
<td>6&lt;sup&gt;(21%)&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Tulare Co. Farm Advisor</td>
<td>53</td>
<td>38&lt;sup&gt;(72%)&lt;/sup&gt;</td>
<td>31&lt;sup&gt;(82%)&lt;/sup&gt;</td>
<td>31&lt;sup&gt;(100%)&lt;/sup&gt;</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Statistical Reporting Service</td>
<td>167</td>
<td>61&lt;sup&gt;(37%)&lt;/sup&gt;</td>
<td>54&lt;sup&gt;(89%)&lt;/sup&gt;</td>
<td>40&lt;sup&gt;(74%)&lt;/sup&gt;</td>
<td>14&lt;sup&gt;(26%)&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Composite Master List</td>
<td>1070</td>
<td>133</td>
<td>115</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a: Percent of operations with fifty or more breeding cattle = (column 2/column 1)*100%

b: Percent participated in survey = (column 3/column 2)*100%

c: Percent of operations that overlapped with other lists = (column 4/column 3)*100%

d: Percent of names which appeared exclusively on each list = (column 5/column 3)*100%
Table 2: Number and percent of registered purebred cattle, use of veterinary services, cows culled due to reproductive problems, use of artificial insemination, and presence of poisonous plants in 115 Tulare County beef breeding cattle operations according to various list frames.

<table>
<thead>
<tr>
<th>List Frame</th>
<th>No. of Operations(^a)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W/Purebred Cattle</td>
<td>Not Using Vet Service</td>
<td>Using AI</td>
<td>W/Poisonous Plants</td>
<td>Culled for Repro Prob.</td>
</tr>
<tr>
<td>California Animal Health Branch (n = 44)</td>
<td>14 (31.8%)</td>
<td>10 (22.7%)</td>
<td>9 (20.5%)</td>
<td>19 (43.2%)</td>
<td>498 (33.5%)</td>
</tr>
<tr>
<td>Statistical Reporting Service (n = 54)</td>
<td>10 (18.5%)</td>
<td>13 (24.1%)</td>
<td>6 (11.1%)</td>
<td>20 (37.0%)</td>
<td>476 (26.0%)</td>
</tr>
<tr>
<td>Auction Yards (n = 81)</td>
<td>14 (17.3%)</td>
<td>17 (21.0%)</td>
<td>11 (13.6%)</td>
<td>19 (23.5%)</td>
<td>562 (27.0%)</td>
</tr>
<tr>
<td>Composite Master List (n = 115)</td>
<td>28 (24.3%)</td>
<td>30 (26.1%)</td>
<td>13 (11.3%)</td>
<td>36 (31.3%)</td>
<td>1218 (36.0%)</td>
</tr>
</tbody>
</table>

\(a\): Percent = (No. of operations/No. in list frame)\(\times\)100%

\(b\): Percent = (No. of cull cows/No. of cull cows on list)\(\times\)100%
Table 3: Comparison of annual morbidity and mortality rates (per 1,000 animals) of various conditions reported for four herds in the NAHMS pilot program and the present study in 115 Tulare County beef cattle herds.

<table>
<thead>
<tr>
<th></th>
<th>PNEUMONIA</th>
<th>PINKEYE</th>
<th>DYSTOCIA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NAHMS</td>
<td>This Survey</td>
<td>NAHMS</td>
</tr>
<tr>
<td>Calves</td>
<td>41</td>
<td>1.3</td>
<td>42</td>
</tr>
<tr>
<td>Young Stock</td>
<td>82</td>
<td>4.4</td>
<td>78</td>
</tr>
<tr>
<td>Cows</td>
<td>—</td>
<td>—</td>
<td>2</td>
</tr>
<tr>
<td>Bulls</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>SCOURS</td>
<td>NAHMS</td>
<td>This Survey</td>
<td>NAHMS</td>
</tr>
<tr>
<td>Calves</td>
<td>12</td>
<td>0.0</td>
<td>45</td>
</tr>
<tr>
<td>Young Stock</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>Cows</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>Bulls</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>FOOT ROT</td>
<td>NAHMS</td>
<td>This Survey</td>
<td>NAHMS</td>
</tr>
<tr>
<td>Calves</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Young Stock</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Cows</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Bulls</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>ABORTION</td>
<td>NAHMS</td>
<td>This Survey</td>
<td>NAHMS</td>
</tr>
<tr>
<td>Calves</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Young Stock</td>
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Morb. = Morbidity rate = [(# cases during 12 months)/(# animals at risk during 12 months)] * 1000
Mort. = Mortality rate = [(# deaths during 12 months)/(# animals at risk during 12 months)] * 1000
NAHMS = National Animal Health Monitoring System
Table 4: Comparison of annual morbidity and mortality rates (per 1,000 animals) of various diseases using two survey methods (NAHMS pilot project and the present study) in four Tulare County herds.

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<th>Disease</th>
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Morb. = Morbidity rate = \[rac{(# \text{ cases during 12 months})}{(# \text{ animals at risk during 12 months})} \times 1000\]

Mort. = Mortality rate = \[rac{(# \text{ deaths during 12 months})}{(# \text{ animals at risk during 12 months})} \times 1000\]

NAHMS = National Animal Health Monitoring System
The development and implementation of a national animal health monitoring system is a tremendously ambitious undertaking. At times, the effort seems overwhelming; however, when the blueprint is well planned and when we focus on taking small steps and we successfully complete prototype projects such as we are doing in our pilot States, this effort does not seem so formidable. Yet our day-to-day decisions continue to be made with a clear sense of overall mission of NAHMS and a commitment to bring this mission to reality. That mission continues to be the quantification of disease problems in our food-producing animals across the U.S. and an assessment of their economic impact.

An early assessment of NAHMS verifies that the project is ending a research and development phase where the methodology for sampling, data collection, analysis, and dissemination of results is being finalized. During this early phase of development, mistakes are unavoidable and a necessary part of making a transition to a national effort. Our learning curve is predictable, and trial and error are part of our strategic plan especially when resources are minimal and prototypes have been initiated. Based on our experiences in this phase, we are now preparing to move into a well structured, standardized phase where refinements and reports will be emphasized and our resources will be appropriately expanded. We have a final year of methodological refinement and evaluation. As our evaluation is completed, a proven, standardized, and totally compatible system will be in place and serve as the cornerstone for building a national animal health monitoring system.

In discussing an early assessment of NAHMS, I will try to focus on some of the more general trends that are common to most of the prototype projects. Acting as steward of this activity over the last several years, several major themes have continued to surface regarding the progressive development of NAHMS. I strongly believe that understanding and effectively managing these issues are essential to the success of the project.

1. NAHMS is being built on the idea that the data collection, analysis, and dissemination of results should be shared activities. Beside Veterinary Services (VS) of the Animal and Plant Health Inspection Service (APHIS), we need and welcome the help of the States, universities, industries, diagnostic laboratories, and other Federal agencies. This has led to a great deal of diversity among people who have become interdependent and interact in complex ways. We find that there are differences in goals, priorities, and beliefs that often result in conflict and the mutual resolu-
tion is difficult. Yet diversity and interdependency are essential ingredients in fostering original ideas and expanding the breadth and scope of information brought to bear on our problems. At the same time, we improve our capacity and expertise which we deem essential to the formation of an effective and valid system. We continually probe and attempt to integrate a balanced vision while still maintaining the integrity of the NAHMS mission. Occasionally, participants choose to adopt adversarial, parochial attitudes and become cynics. Because this attitude is counterproductive, we ask for your ideas, views, and your appreciation of some of the difficulties of managing broad-based projects within this environment of interdependency and diversity.

2. The need for better and more accurate data on animal health has never been greater. This is partly due to the restructuring of animal agriculture where poor decisions are becoming more and more costly, and partly due to rapidly changing technology that allows data to be more accessible. Management and technical decisions are only as good as the data used to make them. Thus, decision makers are demanding new and different services. We have experienced a dramatic increase in interest in NAHMS from a wide variety of potential users of NAHMS information. Producers, researchers, drug companies, animal health officials, legislators, bankers, consumers, university faculty, and industry members have all expressed an interest and assured us of a vital need for data on animal diseases and their economic impact. Activities of a public agency such as APHIS are truly authorized by our external constituents, which are comprised of the groups that I have just mentioned. The experiences gained in our seven participating States have certainly substantiated the idea that there is a growing public demand for a NAHMS. A distinct advantage of having several years of experience working with NAHMS is that it has allowed us to perform a needs assessment of livestock and poultry producers at the farm level. They have overwhelmingly supported, encouraged, and participated in NAHMS. We must all evolve creatively to produce different services as they are demanded or needed. There is unquestionably a new niche for public veterinary services in the future — brokers of information.

3. A final theme that has become apparent through our retrospective look at NAHMS is that changes are taking place with rapid, unprecedented acceleration. The nature of agriculture itself is being reshaped. Our imports are greater than our exports. Research and its applications have allowed us to dramatically improve production; now we are faced with tremendous surpluses. Consumers have changed — they are concerned about how their health may be affected by the foods they eat. Producers with restructured and larger production units will need the skill to manage information as much as to manage animals. Diseases are being recognized as resultants of complex, multifactorial interactions of events and agents over time. The use of biotechnology and genetically engineered
products may revolutionize agriculture and further support the need of NAHMS to help assess these profound implications. All of which has placed a new emphasis on an integrated approach to solving complex animal health problems and a reevaluation of our traditional roles as stewards of this process.

Paul Valery stated that “the trouble with our times is that the future is not what it used to be.” We share some of his anxiety, because the fundamental restructuring and transformation of agriculture are bound to change our concept of animal health and require a reassessment of the public’s needs and of our role during this time of uncertainty. The effect this has on NAHMS has only been to encourage us to work harder and faster. Our data will be needed to define disease problems and their economic burden to producers and define how the monumental changes in agriculture will affect the occurrence of diseases, especially some of the noninfectious disease problems.

Having a good idea and strategic vision is one thing; implementing it can be something else. So, I would like to summarize what we have learned from our efforts to implement NAHMS in the participating States.

— The NAHMS pilot projects represent very successful efforts to take the concept of an animal health monitoring system off the drawing board and implement and test it within the realities of our farm and ranch situations where it must be proven.

— In many instances, and especially with hog producers, private veterinary practitioners are being used infrequently or not at all. Diagnosis of diseases and conditions are usually being made by producers themselves, and herd health strategies are often formulated without professional guidance. Assistance and expertise available through diagnostic facilities are rarely being used. We are encouraged that an increased awareness of diseases and their costs by producers will serve as an inducement to more optimally use professional services.

— Producers are information thirsty and, in most States, approximately 70-80 percent of the randomly selected producers agreed to participate on our initial contact. They all agreed that their respective industries would benefit from NAHMS, yet some were not certain how the information would be used.

— The producers agreed to participate because they were very curious to see how they compared or “measured up” to other similar producers. They also expected reports and summaries which are essential to keep up their interest. Many kept records for the first time and learned that accurate on-farm record keeping will prove to be very beneficial to their operations in the future.

— Costs of prevention and treatment of diseases and losses due to these diseases (mainly death losses) are being tabulated. In Iowa, for example, these costs totaled over a half million dollars for the 55 producers
involved in the 15-month project. When one looks at the animal agriculture across Iowa, it is easy to visualize the tremendous economic impact of disease problems. Yet, these estimated costs are probably quite conservative and will be significantly higher as we learn to more accurately estimate the cost of morbidity. We must also remember that on some farms costs due to infectious disease are not the major economic problem. Waste, nutritional problems, and poor management decisions can and do result in more significant losses in production efficiency. For example in hogs, injuries and neonatal crushing are significant economic events.

— There was a tremendous range in disease costs and direct losses. Within each production group of hogs, feedlot cattle, dairy cattle, and cow-calf herds, there was more than a 20-fold difference in the economic consequences of diseases that were reported. This tremendous interfarm variation was due to: (1) overspending for prevention and treatment; (2) the difference in clinical manifestations of the same disease entities; (3) differences in environmental factors and farm management practices; and (4) differences in how producers respond to and have access to information. Producers' definition of disease is quite variable; many only think of disease in terms of what limits their immediate marketability.

— Diagnostic data from our subsampling proved to be a very valuable component of NAHMS and, although an expensive part of the project, is essential and must be greatly expanded. We need to add more specificity to our generic disease classifications. The diagnostic results help validate our on-farm data. Colorado and Iowa diagnostic data suggest that many herds and flocks of food animals are exposed to the same endemic agents of disease; however, the resulting economic burden varies tremendously. There are other disease factors occurring simultaneously that are responsible for differences in manifestation and losses. Longitudinal studies and a growing data base, such as provided by NAHMS, will hopefully allow us to identify and examine the association and influence of these other disease factors. This information would be very valuable as a decision support system for producers.

— NAHMS data are unique in meeting the needs of the producers. Producers have had accessibility to financial data and accounting services are quite common. Veterinarians have focused on biological data and variables and have a lot of experience in collecting and evaluating biological measurements of animals and disease. However, there have been too few attempts to convert biological variables into economic parameters which is the focus of the NAHMS reports. Information on the true economic impact of problems that can be specifically attributed to certain health-related events will be invaluable and is feasible within the current structure of NAHMS.
— Less than 2 decades ago, the technology and strategic opportunities were not available to implement a NAHMS as we now envision it; i.e., a microcomputer-oriented data base management system (DBMS) in a distributive environment with networking capabilities. NAHMS projects in several of the States have proven that this type of system is possible and, moreover, has already been effectively implemented.

— We are gaining invaluable experience working on the analysis of the data bases that have been created. Data entry, analyses, and retrievals with the generation of reports are evolving into well structured components of our data base system. However, each of us must always remember that a “glossy” report is still only as good as the product derived at the VMO-producer interview; form cannot improve data quality. The substance and validity of the NAHMS information has always been our primary concern. It is really the integrity and involvement of our field personnel and the farmers and ranchers across the U.S. that will ultimately make NAHMS a worthwhile and viable system.

— University faculty have played an important role in our projects and are, to a large degree, responsible for their success. NAHMS has created a lot of interest at the universities. The interaction of the State and Federal VMO's with university faculty was mutually beneficial and a compelling part of this activity.

— The VMO's who interviewed the producers made an outstanding contribution to this project. Although this was a nonregulatory activity, the VMO's had few problems in working in this new environment and enjoyed the change. The criticisms and suggestions of the VMO's were very helpful and used to make changes in new NAHMS projects.

— Nomenclature, coding, and classification of diseases and drug data need further thought and development.

— Data analysis and summations need to be further evaluated and results will be more widely disseminated. The methodologies need a final review, especially some of the complex statistical and mathematical issues.

In public agencies, our concern is creating a rather abstract product — public value. Yet public value can be quite vague and its interpretation can be controversial. We believe that value is bestowed by the constituents we serve, and we must listen to what they are telling us. With this in mind, we have formed a NAHMS Working Group, composed of 10 experts outside APHIS, to help with input and direction in the future expansion of NAHMS. In addition, a NAHMS Users Group is also being formed to gather ideas and criticisms at the grass-roots level. We will continue to give accounts of our progress to industry groups, private practitioners, and other interested parties as we mold our public value products based as users needs.
We have decided to expand sparingly this year and use our resources for a final and thorough evaluation. This includes an indepth assessment of our methods for statistical analysis, sampling and survey design, data collection formats, interviewing skills, data analysis, drawing inferences, and diagnostic subsampling. As part of this effort, a team from Johns Hopkins University, Department of Epidemiology and Biostatistics is helping us perform this important evaluation.

By FY 1988, methodological changes will be made, as necessary, and a data base management system with proven standardized data collection formats, data analysis packages and summary reports will be ready for use by any interested State. A significant expansion in participation is expected at this time. The internal capacity of our agency is being improved through the addition of experts in analytical epidemiology, agricultural economics, biostatistics, and computer technology as we broaden our technical base and move forward toward our national goals.

Finally, I can report to you with confidence that the continuous perfection and the further implementation of NAHMS is a central, immediate objective of VS. There is no consideration of turning back; we are convinced of this project's merit and value and of its firm position as part of our strategic vision of the future that is compatible to our basic mission of protecting America's agriculture.

We are quickly evolving from a successful pilot phase toward a national effort. The support and authorization for NAHMS outside VS is unmistakably loud and clear. Reliable information on diseases and their costs is an overarching need that potentially touches and involves all other USAHA activities and all aspects of animal health programs and issues.

This committee gave its unanimous concurrence to begin a NAHMS effort back in 1981. This was the impetus for us to begin an embryonic attempt at implementation. Today, I ask for your further indulgence and support. The assistance and input from this committee today is just as vital, if not more so, than your encouragement 5 years ago that started us on our way.
NAHMS: VALIDATION OF DISEASE DIAGNOSES
IN FEEDLOT CATTLE

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Colorado began collecting data on the National Animal Health Monitoring System (NAHMS) in 1984. Types of livestock operations included in the first round were beef (cow-calf) herds, beef feedlots, dairy cattle, sheep flocks, and sheep feedlots. Six to 8 NAHMS herds were assigned per VS/APHIS VMO (Veterinary Services/Animal and Plant Health Inspection Service Veterinary Medical Officer). The role of the Colorado State University (CSU) team was to participate in the routine monthly collection of NAHMS data from 8 premises (including 4 beef herds, 1 dairy, 1 sheep flock, 1 sheep feedlot, and 1 beef feedlot) and to conduct a pilot validation study of a beef feedlot operation.

One of the unique features of NAHMS is the testing of the validity of the diagnoses reported by the system. This validation includes subsampling of representative sick and “healthy” animals from some NAHMS premises for the purpose of obtaining specific, laboratory-based diagnoses. The procedures include assessments of the accuracy of the disease information being reported from the farms. Assessment is done by collection of appropriate biological specimens for diagnostic laboratory testing, physical examination and necropsy of subsampled animals, and special observations (including serosurveys and followup to slaughter) of subgroups within the sampled populations. The need has been stated for the information obtained by NAHMS to be both statistically and biologically valid. This need can be accomplished by consideration and exploration of different approaches to validation to determine which are most suitable. The approaches taken in particular geographic areas may vary according to the type of livestock operation, diagnostic capabilities or facilities, desired precision, and availability of funds and personnel time.

Objectives of the CSU diagnostic validation project were (1) to compare on-farm observations and clinical impressions of a feedlot producer with those of CSU, supported by diagnostic tests, in a herd chosen by random selection to participate in NAHMS and (2) to evaluate the procedures and costs associated with the subsampling experience. A beef feedlot was chosen as the initial subject in studies of validation of diagnoses reported to NAHMS since this type of livestock unit in Colorado is unique and characteristic and among the largest in the U.S. Preliminary results of the study are reported below.
NAHMS: VALIDATION OF DISEASE DIAGNOSES

STUDY POPULATION

A large commercial beef feedlot (>30,000 head capacity) located in northeast Colorado was chosen for validation. The lot had been selected by a VSAPHIS stratified random process\(^1\) for inclusion in the routine NAHMS pilot data collection project in Colorado. Each of 4 central hospital areas served approximately \(\frac{1}{4}\) of the feeder pens.

The general procedure at the feedlot for disease diagnosis and treatment consisted of pen checkers who rode or walked through each pen daily and removed any animal (i.e., a “pull”) that they considered needed attention. The pulled animals were brought to the hospital that served the pen of origin, and a “pull card” indicating the reason for pulling was filled out for each animal. Then the animals were processed by the hospital crew for diagnosis and treatment. Each pull was identified by eartag, and a hospital record was completed for these animals. Recovered animals were taken back to their pens of origin by the pen checkers (i.e., “pull crew”).

VALIDATION PROCEDURES

Diagnostic validation consisted of 3 simultaneous approaches: (1) follow-up of 1 lot of cattle (referred to as the cohort) from processing through slaughter, (2) collection of health data on the rest of the feedlot for comparison purposes, and (3) collection of diagnostic specimens from randomly selected animals.

The time period of the diagnostic validation study was May 1985–March 1986, while the period of observation for routine monthly NAHMS data collection at the feedlot was April 1985–April 1986.

(1) **One cohort was selected at random among cattle entering the feedlot within the first 6 weeks of the study period.** Each animal in the cohort was individually identified by eartag and bled for serology at the time of processing. The cohort was observed 3 times/week for general appearance; and any sick animal that was pulled was evaluated prior to treatment. Animals pulled on other days were evaluated on the next visit. A second serum sample and tissue samples for histopathology from organs with gross lesions were obtained at slaughter.

(2) **New pulls from lots other than the cohort were evaluated 3 times/week.** One member of the CSU team (G.R.F.) arrived shortly after the feedlot’s work day began and departed after the treatment of the last new case from routine pen checks. The time spent on the feedlot varied from 4 to 9 hours each visit. Using random numbers generated prior to the visit, 1 or 2 animals were chosen at random for clinical evaluation from among the new pulls brought to each hospital on that particular day.

(3) **Approximately 10% of the daily new pulls were evaluated for diagnostic sampling, with an upper limit of 5 animals per visit due to budgetary and diagnostic lab load constraints.** Each case evaluated was randomly selected from a different hospital, unless 5 animals were
evaluated, in which case 2 were from 1 hospital.

Clinical workup of pulled cohort animals and other pulls sampled randomly consisted of physical exam and collection of biological samples as necessary. A CSU diagnosis was made in as independent a manner as possible. Then the pull card's and the hospital crew's diagnoses were recorded for later comparison with the CSU diagnosis. Specimens collected were nasal swabs in Amies media with charcoal and in virus transport medium for bacterial and viral isolations, feces for Salmonella culture, swabs of abscesses in Amies media with charcoal for bacterial culture, and blood for serology and BVD virus isolation. Specimens were submitted to the CSU Veterinary Teaching Hospital Diagnostic Laboratory (VTHDL) for processing (the VTHDL is a fully accredited laboratory). Since the majority of illnesses expected were respiratory, serologic testing was limited to viral agents commonly associated with respiratory infections in feedlot cattle, i.e., PI-3, IBR, RSV, and BVD.

RESULTS

No less than 151 different diagnoses were entered on the health records by the hospital crew during the observation period. It is these diagnoses that would be entered onto the NAHMS if not condensed into meaningful synonyms. By way of example, the CSU diagnosis and corresponding hospital crew diagnostic categories are given in Table 1 for respiratory diseases.

The validity of diagnoses were examined by comparison between personnel groups (Table 2). The general agreement of CSU with the feedlot records was high, but better with the hospital crew than with the pull card. The latter could probably have been a result of the fact that the CSU clinician worked side by side with the health crew during the visits and had little interaction with the pull crew. That some education of the health crew by CSU might have taken place over the months may be indicated by a slight increase in the diagnostic agreement between CSU and the hospital crew from the first half to the second half of the study period (Table 3). In most cases, diagnosis by the pull and health crews were arrived at independently; but sometimes the health crew observations were influenced by the reason given by the pull crew for sending an animal to the hospital.

Specific etiologic agents isolated are summarized in Table 4. All BVD, IBR, and PI-3 virus isolates were associated with a diagnosis of respiratory disease. The single bluetongue virus (BTV) isolate and 3 of the 5 rhinovirus isolates were obtained from clinically normal animals. Although 4 times as many animals with respiratory disease were tested than without resp. dis., the proportion of respiratory cases from which multiple potential respiratory pathogens was isolated was 8 times greater, indicating that the chances of isolating multiple agents was twice as great if the animal was showing respiratory signs than if the animal was not. The success of
isolation of respiratory pathogens was greatest when both CSU and the hospital crew agreed on the diagnosis.

There was considerable variation between the CSU observations of the cohort lot and the pull records. Only 7 animals were pulled from the cohort of 162 animals which were kept together in the same pen and followed over a 16 week period between processing and shipment to slaughter. The conditions noted by the feedlot health crew for the pulled animals were: 1 pneumonia, 3 footrot, 1 cripple, 1 abscess/hernia, and 1 abscess/hematoma. Some conditions (e.g., papillomas, and vaginal prolapse) were observed by CSU but were not considered important enough by the pen checkers to warrant pulling the animals to the hospital pens. Eight animals with respiratory signs were deemed sick enough by CSU to warrant being pulled.

When the cohort was sent to slaughter, blood samples and tissues were collected at the slaughterhouse. Serology results will be reported later. Since the identification of individual carcasses and organs required keeping track of individual animal tag identifications throughout the process, much careful coordination was required by the CSU team with the feedlot company, slaughter plant personnel, and USDA meat inspectors. This coordination and organ collection and identification of lesions on the kill floor was complicated by the fact that animals were killed at the particular slaughterhouse involved at the rate of 400 head per hour.

Sixty of the 83 (72%) organs tagged during the slaughter procedure were recovered, including 44/63 (70%) heart, kidney, and lung, and 16/20 (80%) of the liver. Observations of conditions seen at slaughter in the cohort animals according to the slaughterhouse company records (Table 5) could be compared to the USDA slaughter condemnation records for all animals killed the same day as the cohort was killed (Table 6). Slaughter results substantiate what was observed clinically — that the cohort was quite healthy and may have been unrepresentative of the lots being fed at the same time at the study feedlot.

VALIDATION APPROACHES

Some of the different approaches, with associated costs, to validation of the disease diagnoses reported by the NAHMS could be evaluated by data obtained in the current study as follows:

1) Regular clinical observations by a NAHMS veterinarian on 2 to 3 feedlot visits per week. This approach would require a NAHMS veterinarian to visit the feedlot for a set time period twice or thrice weekly. These days should be randomized so that visits are not made on the same days of the week through the study period. On each visit clinical observations on randomly selected new cases for that day would be performed. These observations would consist of cursory physical exams only. The NAHMS veterinarian's findings then would be compared to the reason the animal was pulled and the diagnosis made by the treatment crew.
Assumptions for this approach are that the 2 to 3 hour visit was representative of the day, and the day of the visit was a representative day of the week. Since the new cases that would be evaluated would be selected randomly, it is assumed these would be representative cases. Since diagnoses would be made solely by physical exams, etiologic agents and supportive laboratory workup, such as clinical pathology and histopathology, would be absent. This method would suffice for several conditions that occur such as footrot, lameness, prolapses, dystocias and bloat. Also, sufficient general classification of other conditions could be obtained such as respiratory complex, abscesses, metritis and “water belly.” The importance of on site review of data provided by the producer to the NAHMS was demonstrated by the term “sick” (Table 1). The diagnosis was synonymous with lower respiratory disease, but this would only be determined by questioning the hospital crew by trained personnel. Another drawback to this approach is that, depending on how busy the feedlot personnel were, the number of current cases and the time of arrival of the NAHMS veterinarian, the potential exists of not seeing any new cases for that day if only 2 to 3 hours were spent on the feedlot. The cost of this approach would be limited to the time and cost of travel, 4 to 9 hours per week on the feedlot, and 2 to 3 hours per week of office time afterwards. Since the time on the feedlot would be much less for the NAHMS veterinarian than was spent by the CSU clinician in the validation study, more new cases per hospital per visit would have to be evaluated at the 1 or 2 hospitals worked during the NAHMS veterinarian’s stay.

Method (1) would be effective assuming specific or etiologic diagnoses were not required. It is not, however, time efficient for the NAHMS veterinarian. Depending on the proximity of the feedlot, much time may be spent traveling. Also, the potential exists of not seeing any new cases in a 2 to 3 hour visit.

(2) Intensive follow-up of a chosen subpopulation. Here a cohort would be selected at random for following from processing thru slaughter. The assumption needed is that the selected group be representative of the total population (an assumption that may not always hold, as seen in the current study). An advantage of the approach is that one may observe diagnoses missed by feedlot crews. A disadvantage in terms of missing data for NAHMS reports is that a puller may see that an animal is sick but still feeding, so the animal will not be pulled; but the veterinarian may evaluate the animal as sick in terms of traditional signs of illness. If the objective of NAHMS is to be as complete as possible in detecting disease occurrence in feedlot animals, then the approach is useful. But if only economically important conditions are the target, then reliance on the feedlot pull procedures would be sufficient.

(3) Regular clinical observation by a NAHMS veterinarian on 2 to 3 feedlot visits each week accompanied by collection of suitable biological samples for confirmation through a diagnostic lab. This
approach is the same as discussed in (1), except that appropriate samples would be collected for bacterial or viral isolation, serology, clinical pathology, or histopathology to support the NAHMS veterinarian’s diagnosis or identify the etiologic agent of the disease.

The assumptions and drawbacks discussed for approach (1) also exist for approach (3), except that etiologic agents circulating in the population can be determined and specific diagnoses may be made. Inherent in this approach is the added time and expense involved in collecting, storing, delivering and processing the samples. Thus, the approach is considerably more expensive than option (1). Method (3) is superior to (1) in that etiologic agents may be identified or more specific diagnoses may be made. The major drawback is the much higher cost. There is a possibility to cut costs some by development or use of field diagnostic kits and perhaps through advances in diagnostic laboratory techniques or materials. A cost reduction also might be realized from volume processing of subsampling specimens submitted from the NAHMS states to some federal or contracted laboratory.

(4) Submission of biological samples by the owner or private veterinarian on a weekly basis. In this approach the NAHMS veterinarian does not have to travel to the feedlot except for the monthly visits for the routine forms. A set number of bacterial, viral and/or serum samples are sent to a diagnostic lab each week by the feedlot or the feedlot’s veterinarian.

While an advantage to this method is the relatively little time spent by the NAHMS veterinarian, there would be no clinical observations to correlate with the results. To overcome this somewhat, clinical signs could be relayed by the owner or private veterinarian. A disadvantage to the approach would be the loss of randomness. The owner may submit samples from cases he is particularly concerned with or feels are important. The cost of a private veterinarian to take samples might be prohibitive to the owner. Also, if samples are restricted to bacterial culture, viral isolation and serology, only conditions of an infectious nature would be sampled beyond the routine reporting system. The laboratory costs of processing the samples submitted would be the same as in (3).

The results of the current study shows that, at least for a large feedlot operation that utilizes a trained hospital crew, the reliability of most diagnoses would be maintained. The diagnostic agreement varied by disease, with loss of sensitivity of the cooperator’s diagnosis when the diagnostic complexity increased (Table 2, multiple conditions). Also, diagnostic acumen varied by time period (Table 3). It is likely that the latter variation was due to differences in cattle inventories, with greater specificity of diagnoses occurring when the animal numbers where low (in summer when respiratory disease incidence rates are low also) and less specificity at times when the feedlot crews are at their busiest handling
more sick animals (because of higher total numbers of animals at risk and a higher respiratory disease incidence rate in the fall and winter).

This approach would be less costly as far as NAHMS veterinarian time than (1), (2), or (3), the only time spent being office time to record results; however, the sample costs incurred in (3) would also be present here. If etiologic agents are the main concern, this approach would be a good one, but if non-infectious conditions are also of concern, much information may be unavailable or sampling protocols must be expanded (at additional cost).

(5) Paired serology only, the first sample collected at processing and the second sample collected at slaughter. The NAHMS veterinarian would draw serum samples from randomly selected lots of cattle when they are processed at the beginning of their feeding period and, again, just prior to slaughter or at slaughter.

Only 2 trips would be required by the NAHMS veterinarian per lot, with approximately 2 hours required at each bleeding in addition to travel. A disadvantage would be that only infectious diseases would be monitored. Also, comparing serum samples 3 to 4 months apart would miss a rise and fall in titer. Further disadvantages would be that the processing crew at the feedlot will be slowed by the first bleeding. If the second sample was drawn at the feedlot, the lot would be run through the chute unnecessarily, resulting in greater shrink and loss in value to the feedlot. If the second sample is taken at slaughter, a working relationship with the packing plant would have to be developed. Finally it would have to be assumed that the cattle followed were representative of those on the feedlot.

Since this method would only evaluate infectious agents, and only those agents that were selected for screening, and since there would be a 3 to 4 month delay before obtaining the second sample which may miss seroconversions, approach (5) may not be the most desirable. The only advantage is the relatively low cost of NAHMS veterinarian time, but there would still be the diagnostic laboratory expense.

(6) Collection of pathological specimens from slaughterhouse followup of selected feedlot cohorts. The approach is complementary to option (5) and has many of the same advantages and disadvantages. The greatest disadvantages are that the time for agent isolation would have passed and the lesions seen may not be relevant to previous clinical history. Low cost would be the advantage; but this advantage would not seem to outweigh the major disadvantages.

(7) No validation performed; rely on the monthly reporting system only. This approach requires the routine reporting system only and would not try to validate disease occurrence or diagnoses. It would be the least costly and would require no additional NAHMS veterinarian time. Since the approach relies solely on owner reporting it would remain unknown how accurate the disease detection system would be. The approach would
NAHMS: VALIDATION OF DISEASE DIAGNOSES

lack discrimination between specific diseases and would result in duplication of syndrome diagnoses as seen from the results of the current study. Some improvement in this approach might be gained by monitoring diagnostic laboratory reports for the locality, at least to see if increased lab submissions paralleled the frequency of reported diseases and possibly to obtain some information regarding which agents are occurring in the locality. This extra surveillance activity would require additional NAHMS personnel time.

REFERENCES


The authors appreciate the collaboration of Dr. John S. Reif and the cooperation and advice of the VTHDL, especially Drs. Robert L. Jones and James K. Collins. The project was supported in part by USDA/APHIS Cooperative Agreement No. 121698012.

Table 1

<table>
<thead>
<tr>
<th>CONDENSED DIAGNOSES LIST—RESPIRATORY DISEASES, May 1985—April 1986</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSU Synonym</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Lower respiratory</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td>Upper respiratory</td>
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</tbody>
</table>

99
### Table 2
**DIAGNOSTIC VALIDITY BY PERSONNEL GROUP AND DIAGNOSIS,**
May 1985–March 1986

<table>
<thead>
<tr>
<th>Personnel Group Comparisons</th>
<th>Lower Respiratory</th>
<th>Combination Respiratory</th>
<th>Footrot</th>
<th>All Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSU vs. Hospital Crew: (n = 258)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specificity</td>
<td>80.5%</td>
<td>96.0%</td>
<td>97.6%</td>
<td>83.1%</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>93.6%</td>
<td>31.3%</td>
<td>72.7%</td>
<td>53.3%</td>
</tr>
<tr>
<td>Diagnostic agreement</td>
<td>87.6%</td>
<td>88.0%</td>
<td>96.5%</td>
<td>74.4%</td>
</tr>
<tr>
<td>CSU vs. Pull Crew: (n = 214)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specificity</td>
<td>76.8%</td>
<td>96.8%</td>
<td>94.6%</td>
<td>78.0%</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>93.9%</td>
<td>8.0%</td>
<td>60.0%</td>
<td>39.1%</td>
</tr>
<tr>
<td>Diagnostic agreement</td>
<td>86.0%</td>
<td>86.4%</td>
<td>93.0%</td>
<td>66.4%</td>
</tr>
</tbody>
</table>

a-Lower respiratory disease only
b-Respiratory disease in combination with any other diagnosis
n-No. of animals compared

### Table 3
**VALIDITY OF A DIAGNOSIS OF LOWER RESPIRATORY DISEASE: COMPARISON OF PERSONNEL GROUPS AND TIME PERIODS**

<table>
<thead>
<tr>
<th>Personnel Group Comparisons</th>
<th>Time Period—Month/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5/85–9/85</td>
</tr>
<tr>
<td>CSU vs. Hospital Crew:</td>
<td></td>
</tr>
<tr>
<td>Specificity</td>
<td>80.7%</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>92.7%</td>
</tr>
<tr>
<td>Diagnostic agreement</td>
<td>87.2%</td>
</tr>
<tr>
<td>(n = 179)</td>
<td>(n = 79)</td>
</tr>
<tr>
<td>CSU vs. Pull Crew:</td>
<td></td>
</tr>
<tr>
<td>Specificity</td>
<td>78.1%</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>93.0%</td>
</tr>
<tr>
<td>Diagnostic agreement</td>
<td>85.9%</td>
</tr>
<tr>
<td>(n = 135)</td>
<td>(n = 79)</td>
</tr>
</tbody>
</table>

n = no. of animals compared
Table 4
SUMMARY OF AGENT ISOLATIONS BY CSU DIAGNOSIS,
May 1985–March 1986

<table>
<thead>
<tr>
<th>Agents</th>
<th>Number of Positive Animals</th>
<th>Percent Respiratory Cases</th>
<th>P–P score* ≥2+</th>
<th>≥3+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacteria</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Past. multocida</td>
<td>60</td>
<td>85</td>
<td>73</td>
<td>45</td>
</tr>
<tr>
<td>P. hemolytica</td>
<td>47</td>
<td>91</td>
<td>81</td>
<td>60</td>
</tr>
<tr>
<td>Other spp.</td>
<td>15</td>
<td>93</td>
<td>93</td>
<td>21</td>
</tr>
<tr>
<td>Viruses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BVD</td>
<td>14</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>IBR</td>
<td>11</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Rhinovirus</td>
<td>5</td>
<td>40</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>PI-3</td>
<td>1</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>BTV</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

a – Pathogen-potential on the basis of a 0 to 4 scoring system of the extent of culture growth.
b – Clostridium pyogenes, Haemophilus somnus, Pasteurella sp.

Table 5
SLAUGHTER COMPANY CONDEMNATION RECORDS
OF THE COHORT ANIMALS

HEIFERS KILLED 161
AVERAGE LIVE WEIGHT 1020 lb.
AVERAGE CARCASS WEIGHT 648 lb.
  Number <550 lb. 3
  Number 550–600 lb. 29
  Number 601–700 lb. 98
  Number 701–800 lb. 30
DRESS PERCENTAGE 63.53%
LIVERS CONDEMNED
  Abscess 24 (14.9%)
  Distoma 4 (2.5%)
CARCASSES PULLED BUT PASSED
  Cysticercosis (calcified) of heart only, passed for refrigeration: 1
BRUISES ON BACK 4 (2.5%)
No records on heads condemned
Table 6
USDA SLAUGHTER CONDEMNATION RECORDS—
ALL CATTLE KILLED THE SAME DAY THAT THE COHORT LOT WAS SLAUGHTERED.

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEIFERS KILLED</td>
<td>2364</td>
</tr>
<tr>
<td>STEERS KILLED</td>
<td>486</td>
</tr>
<tr>
<td>TOTAL ANIMALS KILLED</td>
<td>2850</td>
</tr>
<tr>
<td>LIVERS CONDEMNED</td>
<td></td>
</tr>
<tr>
<td>Abscess</td>
<td>1067</td>
</tr>
<tr>
<td>Cirrhosis</td>
<td>4</td>
</tr>
<tr>
<td>Distoma</td>
<td>96</td>
</tr>
<tr>
<td>Sawdust</td>
<td>3</td>
</tr>
<tr>
<td>Telangiectasis</td>
<td>6</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>111 (mostly contamination)</td>
</tr>
<tr>
<td>HEADS CONDEMNED</td>
<td></td>
</tr>
<tr>
<td>Abscess-cervical</td>
<td>4</td>
</tr>
<tr>
<td>Abscess other</td>
<td>13</td>
</tr>
<tr>
<td>Acti</td>
<td>3</td>
</tr>
<tr>
<td>Bruises, injuries</td>
<td>5</td>
</tr>
<tr>
<td>Contamination</td>
<td>53</td>
</tr>
<tr>
<td>ANTE-MORTEM CONDEMNED</td>
<td></td>
</tr>
<tr>
<td>CNS disorders</td>
<td>1</td>
</tr>
<tr>
<td>CARCASSES CONDEMNED</td>
<td></td>
</tr>
<tr>
<td>Eosinophilic myositis</td>
<td>2</td>
</tr>
<tr>
<td>Septicemia— down in AM, 101.7 F, discolored carcass, hyperemic carcass lymph nodes:</td>
<td>1</td>
</tr>
<tr>
<td>Acti on head, including lymph nodes; also mediastinal lymph nodes and prefemoral lymph nodes:</td>
<td>1</td>
</tr>
<tr>
<td>CARCASSES PULLED BUT PASSED</td>
<td></td>
</tr>
<tr>
<td>Pneumonia — abscess on lung, well encapsulated, no systemic involvement:</td>
<td>3</td>
</tr>
<tr>
<td>Eosinic myositis on head, carcass free of lesions:</td>
<td>2</td>
</tr>
<tr>
<td>Arthritis, no systemic involvement:</td>
<td>1</td>
</tr>
<tr>
<td>Cysticercosis (calcified) of heart only, passed for refrigeration:</td>
<td>1</td>
</tr>
</tbody>
</table>
REPORT OF THE COMMITTEE ON ANIMAL DISEASE SURVEILLANCE

Chairman: Dr. C. M. Hibbs, Albuquerque, NM
Vice Chairman: Dr. L. J. King, Hyattsville, MD

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The Committee on Animal Disease Surveillance convened with five papers being presented. The Food Safety Inspection Service of the USDA discussed the status of their livestock and poultry disease reporting system (Phase II). This system can be characterized as a publicly accessible network that has expanded utility. Studies have been conducted based on user input and the system will be refined to enhance its retrievability and extend its usage. Presenters reported that data will be used for teaching, research, correlations, performance evaluation, staffing, plant quality control, management decisions and trend analyses. The use of trend analyses to forecast disease occurrences as they relate to seasonal, geographical and plant variability has a great deal of potential to be used in conjunction with other disease surveillance and detection systems.

Dr. Harvey Gosser, Director of the Georgia Veterinary Diagnostic Laboratory at Tifton, GA reported on the use of computerized epidemiologic studies recently implemented at this laboratory. This paper demonstrated that electronic data processing is not limited just to business and accounting functions in today's diagnostic laboratories. The Georgia experience shows the epidemiologic value of laboratory data. Trends, prevalence rates, geographical and toxicity surveys are examples of how their data are being used. This extended use for epidemiology suggests that laboratory data will be much more valuable as a surveillance tool in the future.

The National Animal Health Monitoring System (NAHMS) is the new name for what has recently been termed NADDS, the National Animal Disease Detection System. There were three papers dealing with NAHMS and remarks by Dr. Bob Bohlender of the National Cattlemen Association (NCA). Dr. Lonnie King of APHIS retrospectively assessed the NAHMS
effort over the last few years. NAHMS is completing a research and development phase. Experiences during this phase are serving as the cornerstone for building a national monitoring system. The fact was stressed that there has never been a greater need for better and more accurate data on diseases of food-animals and their economic impact. Producers and consumers are demanding different services and have different needs today. The restructuring of agriculture has placed a new emphasis on an integrated approach to solve complex animal health problems and a reevaluation of the traditional roles of public veterinary medicine. To producers, the greatest utility of NAHMS data is the conversion of biological and disease data into economic parameters which served as a basis for better decision making and herd health strategies. Data from NAHMS is changing the concept of animal disease as we learn to appreciate multiple causation, the importance and economic burden of noninfectious agents and the essential role of management factors. Because of the tremendous support for NAHMS, APHIS is convinced of its merit and the wisdom to expand it to a national level.

Dr. Robert Bohlender, representing the NCA, asked for the further support of this committee for the NAHMS effort. The NCA recognized a new consumer emphasis for animal health. The indiscriminant use of vaccines and drugs is being scrutinized by consumers. Besides identifying occurrences of diseases, Dr. Bohlender suggests the NAHMS data can assess the producer's response to disease. Our past encouragement to solve all disease problems through vaccines and drugs may have led us to a drug dependent industry for which the public is now holding us accountable. NAHMS data can assist in documentation of this problem and also assist researchers in their investigation of the complex and integrated events that produce disease.

Two additional papers focused on NAHMS methodologies. California list frames were compared and contrasted with regard to sampling strategies. Colorado State University (Dr. Mac Vean) discussed the benefits of various validation approaches to confirm the diagnoses of feedlot cattle diseases. Both of these papers are being submitted for publication in the USAHA Proceedings. We think this committee has a wide scope and ask the officers of USAHA to assist us in directing our efforts to obtain the most for all concerned.

Finally, as the new chairman for the committee on Animal Disease Surveillance, I would like to recognize the past contributions of past chairman, Dr. George Poppensieck. The USAHA is truly indebted to his valuable services and we wish him a complete and speedy recovery from a recent health setback.
GENETIC ENGINEERING OF NOVEL ANIMAL VIRUS VACCINES
Saul Kit, Ph.D.
Division of Biochemical Virology
Baylor College of Medicine
Houston, TX 77030

Summary

Conventional virus vaccines have numerous shortcomings. They are neither as safe as they ought to be, nor as efficacious. The shortcomings of conventional vaccines can be overcome through genetic engineering. The objectives of genetic engineering are to provide the producer and the practitioner with vaccines that are safer and more compatible with producer practices. The modified-live thymidine kinase deletion mutants of pseudorabies virus and infectious bovine rhinotracheitis virus provide examples of safe, efficacious, rationally designed, user friendly, veterinary vaccines. All vaccines, whether conventional or genetically engineered, ought to be evaluated by the same stringent standards, to insure their safety, purity, potency, and efficacy, and to verify that they do not have a negative environmental impact.

Conventional Virus Vaccines

Conventional virus vaccines consist of modified-live viruses (MLV) and killed viruses prepared by modifications of the procedures introduced by Pasteur at the end of the nineteenth century. In the case of MLV vaccines, these procedures entail the serial passage of field strains, or mutagenized field strains, in foreign hosts or in heterologous cell culture systems. Selective pressures are created as the viruses adapt to their new hosts or to tissue culture conditions, thereby favoring the growth of variants with new biological properties. Among the variants are viruses that cause minimal damage to their hosts. These attenuated strains may be identified by animal pathogenicity tests of each of the serial passages, at best a tedious and empirical process. If the tests show that pathogenicity is insufficiently reduced, the serial passages are continued or additional heterologous hosts may be tried.

The preceding methods for obtaining vaccines have numerous shortcomings that tend to reduce their safety and efficacy and their acceptance by users. To begin with, the number of mutations, their location on the viral genomes, their physiological functions, and the passage number in which they occur are usually unknown and unpredictable. Second, although conventional MLV vaccines may be comparatively safe for their normal hosts, they may still be virulent for other animal species. Third, the uncritical injection of viruses into foreign hosts or the repeated passage of the viruses in heterologous cell lines has the potential for altering the host range and, hence, for accidentally spreading the virus to unrelated...
species, thereby initiating man-made diseases. For example, the virus that causes canine epidemic enteritis and myocarditis is generally considered to be a variant of feline parvovirus or mink enteritis virus rather than a true canine parvovirus. The sudden appearance and rapid dissemination of this feline parvovirus variant in dogs raises the unpleasant possibility that a switch in host range occurred during laboratory manipulations. It is also noteworthy that the origin and genesis of mink enteritis virus, observed for the first time in ranch mink in Canada in 1947, have never been explained in detail. Furthermore, conventional MLV vaccines are sometimes genetically unstable. That is, they can revert to virulence. For example, infants vaccinated with the MLV poliovirus type 3 (Sabin) vaccine excrete pathogenic revertants, thereby posing a hazard for the vaccinees and their contacts. Also, vaccines consisting of temperature-sensitive (ts) or cold-sensitive (cs) mutants have the potential of reverting to virulence because ts and cs mutants usually harbor missense mutations, and missense mutations tend to back-mutate under selective pressure. One of the commercially licensed infections bovine rhinotracheitis virus (IBRV) vaccines is a ts mutant.

Another shortcoming of ts mutant vaccines is their inability to replicate in the deep tissues of the body. To illustrate, the ts IBRV vaccines are administered intranasally (IN), which is difficult and time consuming when large numbers of cattle have to be vaccinated. Vaccination of cattle by the intramuscular (IM) route fits more readily into management practices, but the IM route is inappropriate for ts mutants.

Killed-virus vaccines are generally considered to be safer, though less efficacious, than MLV vaccines, but conventional killed-virus vaccines also have shortcomings. Outbreaks of foot and mouth disease (FMD) have been traced to the incomplete inactivation of a conventional FMD vaccine. Killed virus vaccines have been particularly ineffective in the instance of animal herpesvirus vaccines. They are unlikely to prevent infection of vaccinated animals by virulent field strains and the establishment of latency. In addition, they are not always effective in preventing disease. Pneumabort-K, an equine herpesvirus type 1 (EHV-1) vaccine, provides a recent dramatic example of a killed-herpesvirus vaccine failure. Pneumabort-K was introduced in 1980 to prevent EHV-1-induced abortions and respiratory disease. Prior to 1980, most abortions were caused by an unrelated EHV-1 strain. After 1980, however, an EHV-1 (subtype B) variant of the parental Pneumabort-K strain emerged as the truly epidemic strain causing abortion storms in California, South Dakota, and the United Kingdom.

The specific evolution and spread of new virulent virus forms is a fact of life. However, conventional vaccines are not designed to protect against new and virulent forms of viral diseases, as is painfully apparent from the yearly need for new human influenza vaccines to cope with the constant hereditary alterations in the hemagglutinins and neuraminidases of the
influenza virus family. Infectious bovine rhinotracheitis—-infectious pustular vulvovaginitis (IBR-IPV) is caused by bovine herpesvirus type 1 (BHV-1). Until 1970, IBR-IPV was a well-known cause of morbidity in Europe, the United States, Australia, and New Zealand. After 1972, however, IBR of a more severe form became widespread in Western Europe and the United Kingdom. The suddenness of the change incriminated new and more virulent forms of IBRV (BHV-1), which were either imported in carrier animals or produced by intrinsic mutations of "virulence" genes. IBRV strains isolated by German workers produced IPV if inoculated intravaginally (IVag); only the newer isolates of IBRV-IPV produced severe respiratory disease when given IN. The Belgians in particular believed viruses with new tissues tropisms had been imported from Canada in 1972 through asymptomatic carriers or incubating animals ("la grippe canadienne"). The case is complicated further by reports that IBRV has been isolated from seronegative animals. This observation strengthens the hypothesis that imported tested animals may have brought an exotic strain of IBRV into Europe.

During the past 2 years, outbreaks of Aujeszky's disease in finishing and adult age swine were seen in which the predominant clinical signs and lesions related to the respiratory tract. There have been high morbidity and 5 to 10% mortality. Studies on the restriction nuclease patterns of the pneumotropic field strains have shown that they differ genetically from the prevalent virulent strain that caused abortions and mortality in suckling pigs, but only minimal clinical disease in older swine. Despite conventional vaccines, test and slaughter policies, and regulatory inhibitions, naturally occurring pneumotropic strains of increased virulence for 60 kg pigs have emerged in the United States. In summary, conventional vaccines are far from ideal with regard to safety and efficacy. The evolution of conventional field strains constantly occurs. Outbreaks of disease due to more virulent virus strains take place and are rapidly transmitted to different continents.

Genetically Engineered Designer Vaccines

The best way to overcome the shortcomings of conventional vaccines is through the application of human knowledge and intelligence. The approaches are straightforward. "Heritable virulence factors" determine pathogenicity of viruses and bacteria. These factors can be identified through observation and experiment and then eliminated. The tools to accomplish this are available through recombinant DNA technology. To illustrate, I will focus on genetically engineered herpesvirus vaccines recently developed in my laboratory.

A large body of experimental evidence has accumulated in recent years, showing that herpesvirus virulence is multigenic. The herpesvirus-encoded thymidine kinase (TK) gene is one of the genes required for pathogenicity. The reasons are as follows. Wild-type, TK⁺ her-
pesviruses grow to high titers in mitotic (S-phase) cells and in nonmitotic (G1 or G0 phase) cells. TK- herpesvirus mutants also grow to high titers in mitotic cells, but replicate very poorly in G1 or G0 phase cells. Many of the herpesviruses are neurotropic; that is, after initiating infections in the respiratory mucosa and subadjacent or associated lymphoreticular organs, they enter sensory nerve cells, move by axonal flow to the sensory ganglia, and there establish latent infections. From the sensory ganglia, they spread to the central nervous system, where they may cause vasculitis and nervous tissue degeneration. TK- herpesvirus mutants replicate poorly in neurons. Hence, they are less likely to establish persistent infections in nonmitotic cells, to spread to the central nervous system, and to recrudesce from latency. Therefore, to produce safer herpesvirus vaccines, our strategy was to engineer deletions and, possibly, frame shift mutations in herpesvirus TK genes.

A clone (No. 5) of the TK+ Bucharest (BUK) strain of PRV that had been obtained by passing a PRV field isolate over 800 times in heterologous chick embryo cells was used as the starting material for the development of a new vaccine by the Baylor College of Medicine and NovaGene, Ltd. TK+ PRV(BUK) had already been used as a vaccine in Europe for over 25 years and in the U.S.A. for 8 years. During the past year, 3,578,330 doses of MLV PRV vaccines and 9,353,775 doses of killed PRV vaccines were produced. A deletion of 148 bp was engineered by the marker transfer technique in the coding region of the PRV(BUK-5) TK gene to completely inactivate its functions. The TK- deletion mutant thereby produced was called PRV(BUK-dl3) (United States Patents Nos. 4,514,497 and 4,609,548). On January 16, 1986, after extensive tests for safety, purity, potency, and efficacy, TK- PRV(BUK-dl3) was licensed by the U.S.D.A. for manufacturer and sale in the U.S.A. — the first genetically engineered virus vaccine to be brought from the laboratory to the marketplace.

Prior to the genetic engineering of the TK deletion in the parental PRV(BUK-5) virus, restriction endonuclease analyses had revealed that the parental TK+ PRV(BUK-5) differed in its DNA from virulent TK+ Aujeszky (Auj) disease strains of PRV as follows. Unlike TK+ PRV(Auj), TK+ PRV(BUK-5) had a small duplication downstream from the coding region of the TK gene, and a translocation of the terminal sequence of the unique long segment (U_L) to the junction of U_L with the unique short (U_S) segment. In addition, TK+ PRV (BUK-5) exhibited a 3.5 kb deletion in the U_S segment. Very recent work revealed that the PRV gene encoding glycoprotein gI (120,000 mol wt) is encoded in the deleted U_S segment. This same 3.5 kb deletion occurs in other PRV vaccine strains, e.g., the TK+ Bartha and NIA-4 strains of PRV. Furthermore, genetic engineering to restore the deleted gene encoding gI through the marker transfer methodology restored pathogenicity to the attenuated TK+ vaccine strains. PRV glycoprotein gI has regions of sequence homology to HSV-1 glycoprotein gE, which functions as a receptor for the Fc portion of
immunoglobulins. PRV gI may also have an important role in tissue tropism and the spread of PRV in vivo.

At the time that we isolated TK- deletion mutant PRV(BUK-d13), we knew that PRV glycoprotein gIII (92,000 to 97,000 mol wt) had regions of sequence homology with HSV-1 glycoprotein gC, and that, even though HSV-1 gC was an important immunogen, and functions as a C3b receptor, it was not essential for infectivity or virus replication in cultured cells. Therefore, we engineered a 1.1 Kb SaII sequence deletion in the coding region of the gIII gene of PRV(BUK-d13) to produce the second generation vaccine virus, TK- PRV (dlg92/dltk) (patent pending). The purpose of this deletion was to obtain a PRV "marker" strain so that vaccinated pigs could be distinguished from pigs infected with field strains by simple serological tests.

Experiments demonstrated that, as expected, PRV(dlg92/dltk) replicated to high titers in porcine and rabbit cells over the temperature range of 30° to 39.1° C and that PRV(dlg92/dltk) infection failed to induce TK activity or the incorporation of exogenous 3H-thymidine into the nuclear DNA of mutant TK- rabbit cells. A series of experiments also showed that domestic and feral pigs infected with field strains of PRV, or challenge-exposed experimentally to virulent PRV strains, or vaccinated with the PRV(BUK-5) or PRV(Bartha) strains all had antibodies to PRV gIII. However, pigs vaccinated with PRV(dlg92/dltk) did not raise antibodies to gIII, nor did cultured cells infected with PRV(dlg92/dltk) synthesize any detectable gIII glycoprotein.

PRV glycoprotein gIII has been purified by Concanavalin A-Agarose affinity gel chromatography from cells infected with the TK+ PRV(BUK-5) or the TK- PRV(BUK-d13) vaccine strains and labeled at 5 to 24 hours after infection with 3H-mannose. Figure 1 shows that the major portion of these PRV glycoproteins were eluted from the gels with 200 mM α-methylmannoside (fraction E200). The eluted proteins were then immunoprecipitated with PRV antisera and analyzed by sodium dodecyl sulfate (SDS)-polyacrylamide gel electrophoresis (PAGE) and autoradiography. Figure 2, lanes 1 and 3, show that the gIII (97,000 mol wt) glycoprotein was precipitated (together with other major glycoprotein bands) from the 200 mM α-methylmannoside (fraction E200) eluate by hyperimmune antisera No. 18705, but not by antisera WP2, which was raised by twice immunizing pigs with PRV(dlg92/dltk). Serum from normal pigs (NS) did not immunoprecipitate 3H-mannose-labeled proteins. Figure 2, lanes 6 and 8, show that when the E200 eluate was first immunoprecipitated with WP2 antisera and then with antisera 18705, the antisera 18705 precipitate contained only purified glycoprotein gIII. As expected, treatment of the E200 eluate twice with antisera WP2 did not precipitate glycoprotein gIII (Fig. 2, lane 7). The preceding observations and experiments demonstrate the PRV glycoproteins gIII or gI, or both gIII...
and gI, can be used in tests to distinguish vaccinated pigs from those infected with field strains. All infected pigs develop antibodies to a disulfide-linked glycoprotein complex, gIIa, gIIb, gIIc (mol wghts 120,000, 74,000, 58,000) and to gI and gIII. Pigs vaccinated with TK⁺ PRV(BUK-5) or TK⁺ PRV(BUK-dl3) also develop antibodies to glycoproteins gII and gIII, but not to gI, while pigs vaccinated with the second generation deletion mutant, TK⁻ PRV(dlg92/dltk) develop antibodies to glycoprotein gII, but not to gI or gIII. Two markers are superior to only one in evaluating the serological status of a herd.

Besides the TK deletion mutants of PRV, an IBRV TK deletion mutant has been genetically engineered by NovaGene, Ltd. and the Baylor College of Medicine. This mutant, designated IBRV[(NG)dltk] (patent pending), is interesting because it contains a "NovaGene" brand marker sequence inserted in the virus from which the coding region of the IBRV TK gene has been deleted. Although IBRV[(NG)dltk] has not as yet been tested for safety and efficacy, a mutagen-induced TK⁻ IBRV mutant (United States Patent No. 4,569,840), the grandparent of IBRV[(NG)dltk], has been tested and found to be both safe and efficacious. ³

Why are Genetically Engineered MLV Vaccines Superior to Conventional MLV Vaccines?

In contrast to the changes that occur randomly in conventional virus vaccines, the how, why, when, and where of hereditary alterations introduced into genetically engineered vaccines are rationally planned and confirmable by analyses of restriction nuclease patterns, molecular hybridization, and sequencing. Deletion mutations, for example, are made to eliminate genes controlling pathogenicity. In the case of our TK⁻ mutants of PRV and IBRV, all laboratory attempts to select for TK⁺ revertants have been unsuccessful. The TK⁻ mutations have also been stable after animal passages. Both deletion of virulence factors and genetic stability contribute to increased safety. The genetically engineered PRV and IBRV vaccines isolated at Baylor are also advantageous because they replicate efficiently over the temperature range of 30 to 39.1 C. Hence, the user has the option of using either the IM or IN routes of administration.

Safety studies have demonstrated that the mutagen-induced TK⁻ IBRV(B8-D53) grandparent virus strain used to construct deletion mutant TK⁻ IBRV[(NG)dltk], can be administered safely to pregnant cows by the IN, IM, or intravaginal routes. ³ This vaccine did not cause adverse clinical signs in the pregnant cows and protected them from respiratory disease after challenge-exposure to the virulent TK⁺ IBRV(Cooper) strain. The vaccinated and challenged cows gave birth to live calves, five of which were tested serologically before receiving colostrum from their mothers. These five calves were seronegative for IBRV antibodies, showing that IBRV did not cross the placenta to infect the fetus.
GENETIC ENGINEERING OF VIRUS VACCINES

It is well known that, not only pigs, but also cattle, sheep, and rodents are susceptible to fatal infections by PRV. Fortunately, however, there have been no reports of human infections on pig farms or in laboratories engaged in experiments on Aujeszky's disease. Fatal iatrogenic exposure of lambs to conventional TK⁺ PRV vaccines through the use of contaminated syringes has been described in the U.S.A. and Europe. Fatal experimental infections of lambs with conventional TK⁺ PRV vaccines have also been described, even at very low virus dilutions.¹⁹⁻²³ In contrast, safety studies carried out in calves have demonstrated that TK⁻ deletion mutant PRV(BUK-dl3) does not produce adverse effects, even when injected at over $10^8$ PFU/calf.²⁴

Pilot experiments to evaluate the safety of our vaccine in lambs at very high dose levels have been carried out (Table 1). Each of two lambs were inoculated intravenously (IV) with 2 ml of either the TK⁺ PRV(BUK-5) conventional vaccine virus or the TK⁻ deletion mutant TK⁻ PRV(BUK-dl3) at doses of about $10^9$ PFU/lamb. Two additional control lambs were included in the study. The two lambs inoculated with TK⁺ PRV(BUK-5) died 4 to 5 days postinoculation. Both showed a febrile response of $10^6$° to $10^8$° F. The two lambs inoculated with TK⁻ PRV(BUK-dl3) survived, as did the uninoculated controls. The TK⁻ PRV(BUK-dl3) inoculation did induce a febrile response on days 2 and 4, but no other clinical signs of disease were observed.

On day 50, the yearling ewes which survived the very high dose of TK⁻ PRV(BUK-dl3) vaccination and the two contact controls were challenge-exposed IV with $10^6$ PFU/lamb of the virulent Indiana-Funkhauser (Ind-F) TK⁺ strain of PRV (Table 2). Both control sheep died 4 to 5 days postchallenge. The TK⁻ PRV(BUK-dl3)-vaccinated sheep survived challenge. A one-degree febrile response was noted on day 8 postchallenge, but no other signs of clinical disease were noted. A positive virus-neutralizing antibody response was observed in the TK⁻ PRV(BUK-dl3)-exposed lambs. It should be noted that the contact controls remained healthy and serologically negative to PRV prior to challenge-exposure with TK⁺ PRV(Ind-F) on day 50. Susceptibility to the virus was also confirmed by the virus challenge studies (Table 2).

Experiments with outbred CFR mice revealed that three of five mice were killed after IP infection with the conventional TK⁺ PRV(Norden) and TK⁺ PRV(Pittman-Moore) vaccines at $10^4.59$ and $10^3.59$ TCID$_{50}$/mouse, respectively.¹⁸ However, mice survived IP infection with $10^{10.6}$ TCID$_{50}$/mouse of the first and second generation TK⁻ deletion mutant vaccines, PRV(BUK-dl3) and PRV(dlg92/dltk). Five out of five athymic (nu/nu) mice were also killed by the conventional TK⁺ vaccines, whereas athymic mice showed no adverse effects following IP inoculation with the first and second generation TK⁻ deletion vaccines at $10^{7.5}$ TCID$_{50}$/mouse. Mice vaccinated with $10^5$ or $10^4$ TCID$_{50}$/mouse of the TK⁻ deletion vaccines were also protected after challenge-exposure to lethal doses ($10^5.4$
Safety studies conducted in pigs have shown that pigs vaccinated with TK- PRV-BUK-d13) are highly unlikely to transmit the virus to contact controls. In one study, ten 3-day-olds piglets were vaccinated IP with TK- PRV(BUK-d13). Nasal swabs were taken on each of the first 10 days postvaccination. Virus was recovered from two piglets, but only on day 5 postvaccination. The amount of virus recovered was less than 60 TCID₅₀ and could not be transmitted to unvaccinated piglets. Piglets vaccinated with 10⁵ TCID₅₀ of TK- PRV(BUK-d13) were protected after challenge-exposure with 10⁷ TCID of TK+ PRV(Ind-F). Postchallenge shedding of virulent TK+ PRV was reduced in vaccinated animals. Safety in pregnant animals was also demonstrated.

A pilot experiment demonstrating the safety and efficacy of second generation vaccine in pigs has also been performed. Two pigs, 6 weeks of age, and seronegative for PRV, were twice vaccinated IM with about 8 × 10⁸ PFU of TK- PRV(dlg92/dltk) at 21-day intervals. Serological tests showed that the pigs developed antibodies to PRV but appetite never decreased and no adverse effects were noted. Fourteen days after the second vaccination, the pigs were challenge-exposed IM with about 4 × 10⁸ PFU of the virulent TK+ PRV(Ind-F) strain. Again, no adverse reactions were noted. Weight gains occurred at normal rates for commercially raised pigs and both remained vigorous and healthy.

Vaccination/eradication experiments have been performed on quarantined farms and attest to the safety of TK- deletion mutant, PRV(BU-dl3). One such study was performed on a quarantined farrow-to-finish farm in Lometa, Texas. On June 26 (27), 1984, 1,275 pigs, including about 200 pregnant sows, were ear notched and vaccinated with 10⁷ PFU/pig of PRV(BUK-dl3). On July 18, 1984, 125 piglets born to sows within 3 weeks or less of farrowing were also vaccinated. All piglets born after July 18, 1984 served as sentinel controls. These piglets were also later utilized as replacement gilts. No adverse effects were observed. However, serological tests conducted on the sows and replacement gilts demonstrated that anamnestic responses could serve to identify those pigs infected with a virulent field strain so that animals carrying the virulent field strain could be culled from the herd. More than 2 years have now elapsed from the time of the first vaccination. On May 23, 1986, 220 blood samples were obtained from the breeding herd and analyzed at the Texas Veterinary Medical Diagnostic Laboratory. One hundred and twelve of these were from previously vaccinated sows; the remaining ones were from unvaccinated replacement gilts. Sixteen of the previously vaccinated sows had virus neutralization titers of 1:2, three had titers of 1:4, and all other pigs were seronegative. The 19 seropositive sows represented only 18% of residual responders, considering that only about half of the pigs tested responded serologically in the original vaccination. The data indicate that:

(i) the vaccine had been effective in containing the PRV field virus, as
GENETIC ENGINEERING OF VIRUS VACCINES

evidenced by the clean-up of the herd; (ii) the vaccine virus was not shed into the environment; and (iii) contact transmission via recrudescence of latent virus from vaccinated pigs was not a factor on this farm. Transmission did not occur from vaccinated boars to sows they impregnated, from the sows to their babies, and from the unvaccinated “sentinel” piglets to other pigs on the farm.

Vaccination/eradication experiments have also been initiated recently on quarantined farms in Nebraska and North Carolina. On June 12, 1986, all animals on each of two premises on a Nebraska farm, consisting of about 1,500 pregnant sows and a total of about 10,000 pigs of all ages were vaccinated with PRV(BUK-dl3). Each week thereafter, approximately 670 newborn piglets 12- to 72-hours old were vaccinated. The baby pigs were vaccinated a second time at about 9 weeks of age. Thus, over 10,000 newborn piglets have already been vaccinated on the Nebraska premises. The vaccination/eradication experiment on the North Carolina farm, which is of the same size as the Nebraska farm, was initiated early in September of 1986. About 1,000 pregnant sows and about 3,000 newborn piglets have already been vaccinated on the North Carolina farm. No adverse effects have been reported on either the Nebraska or the North Carolina farms.

Do Deletion Mutants Extend Host Range?

It has been suggested that deletion mutants pose unknown risks because viruses with deletion mutations might exhibit an altered host range; hence, new species of animals might be susceptible to infection. This proposal is fallacious and the concern is misguided.

First, viral deletion mutations are common in nature. As already noted a 3.5 kb deletion of the BamHI-12 fragment occurs in the conventional TK⁺ Bucharest, and also in the Bartha, and NIA-4 vaccine strains, and this deletion contributes to the avirulence of these vaccines. A deletion at 0.76 to 0.79 map units (between the α27 and α4 genes) of the HFEM strain of HSV-1 has been described. The HFEM strain is attenuated for mice and tree shrews. Marker transfer of the 0.76 to 0.79 map unit sequence from HSV-1(F) to HSV-(HFEM) restores virulence. Deletion mutations have been reported in clinical isolates and vaccine strains of varicella-zoster virus, and in nononcogenic, replication-competent strains of Herpesvirus saimiri. Deletion mutations have been observed in the glycoprotein gC gene of HSV-1 strains selected for resistance to monoclonal antibodies. Deletion mutations have been described for poxviruses, e.g., vaccinia and rabbit pox. Thus, the genetic engineering of virus deletion mutations does not produce exotic organisms.

Second, the suggestion that deletion mutants may exhibit an extended host range fails to take into account the fact that virus infection is initiated by the interaction of viral surface proteins (e.g., reovirus hemagglutinin, glycoproteins of enveloped viruses) and cell receptors.
be altered by a change in the amino acid sequence of a virus surface protein (e.g., influenza virus), but host range cannot be extended by the deletion of the virus “receptor” protein. If John Doe loses the key to his house, he will be unable to enter his own house, but he certainly will not have an increased capability to enter his neighbor’s house.

Third, it should be understood that it is the loss of or changes in host factors that determines the host range of viruses. For example, viruses that are apathogenic for normal hosts may be pathogenic for hosts with genetic immunodeficiencies. At the cellular level, SV40 virus replicates efficiently in monkey and human cells, but only initiates an abortive infection of mouse cells. In abortive mouse cell infections, early T-antigens are expressed, but SV40 DNA and infectious particles are not made. Ten years ago, I suggested that monkey and human cells differed from mouse cells in that they contained SV40 essential replication factors (SERF). Recently, Murakami and coworkers have identified the postulated SERF.\textsuperscript{36} A DNA polymerase α-DNA primase complex from either monkey or human cells is required from SV40 DNA replication. The DNA polymerase α-DNA primase complex from mouse cells cannot substitute for the monkey-human cell enzymes. However, the addition of purified DNA polymerase α-DNA primase complex isolated from human cells can activate a mouse cell extract for SV40 DNA replication, whereas mouse cell extracts alone are inactive. In short, positive host cell factors determine host range at the cellular level. Deletion of these factors does not extend host range.

Genetically Engineered RNA Virus Vaccines

Live RNA virus vaccines have the inherent problem of risk of reversion to virulence upon repeated passages. The rate at which spontaneous mutations occur is especially high in single-stranded RNA genome replication ($10^{-3}$ to $10^{-4}$) as compared to double-stranded DNA replication ($10^{-8}$ to $10^{-11}$). That the single-stranded RNA genome of poliovirus is not an exception to this high rate of mutation was demonstrated when plaque-purified viruses from the same seed of poliovirus were characterized after a few independent passages. The rapid accumulation of spontaneous mutations has been attributed to the absence of proofreading and editing functions in RNA replication.

One possibility for “stabilization” of the genotypes of poliovirus is to carry out large-scale propagation of the genome as complementary DNA (cDNA) cloned in bacterial plasmids. Plasmids containing full length copies of plus-sense poliovirus cDNA fused to transcription and regulatory sequences from other sources, such as SV40, produce high levels of infectious poliovirus when transfected to monkey cells. Thus, infectious cDNA clones may be used to preserve the “vaccine quality” of modified live polioviruses (or other picornaviruses) and to provide a potentially unlimited supply of seed virus for polio vaccines.\textsuperscript{37}
With the advent of recombinant DNA technology and the production of cloned poliovirus cDNAs, analyses of the molecular basis of virulence at the level of nucleotide sequencing has become a reality. The complete nucleotide sequence of the virulent Mahoney strain of poliovirus and of all three Sabin vaccine serotypes have been determined. Analyses of pathogenic revertants of the Sabin type 3 vaccine strain have shown, for example, that a change in nucleotide 472 of the 5' noncoding region of the vaccine virus is responsible for neurovirulence. Thus, recombinant DNA technology opens the door to site-specific mutagenesis of picornavirus cDNAs, to the construction of recombinant cDNA clones in which portions of the cDNAs of vaccine serotypes are exchanged, and to the construction of chimeric plasmids from cDNA clones of different picornaviruses, e.g., poliovirus and coxsackievirus. In summary, designer vaccines constructed through genetic engineering open the possibility for the design of safer and more stable RNA virus vaccines.

**Eukaryotic Virus Vectors**

A favorite pastime for molecular biologists is the genetic engineering of eukaryotic vectors. Virus species from several different families have been used to construct vectors, which may serve: (i) the purely research purpose of shuttling genetic information between eukaryotic and prokaryotic cells; (ii) as expression systems for the production of foreign antigens or for the delivery of immunogens to animals; and (iii) for gene therapy in the correction of hereditary defects. Genetically engineered hybrid DNA viruses containing inserts of foreign genes may be particularly useful for the study of dangerously pathogenic viruses, such as rabies, and for the analyses of "exotic viruses," such as African swine fever, foot and mouth disease, and rinderpest; these exotic viruses can now be studied only at highly contained facilities such as the U.S.D.A. facility at Plum Island.

Baculovirus vectors are advantageous as helper-independent, viral expression systems for the production of high levels of glycosylated proteins. The latter may be useful as diagnostic reagents and as submit vaccines (e.g., influenza virus hemagglutinin), or as therapeutic agents (e.g., interferon, interleukin 2). Retroviruses appear to be attractive candidates for efficient gene transfer to hematopoietic progenitor cells. The lymphotropic herpesviruses, such as herpesvirus saimiri, may also serve as vectors to introduce foreign genes into lymphocytes. Other potential virus vectors that have been studied are SV40, polyoma virus, bovine papilloma virus, parvoviruses, and adenoviruses. Each of these has advantages, but the major disadvantages are their small genome size, thereby limiting the size of their inserts, the need for helper viruses, and potential oncogenicity. Vaccinia virus, however, has been, by far, the center of the greatest interest with regard to use as a eukaryotic cloning and expression vector. There are several reasons for this, including: (i) the size of the vaccinia virion and its DNA genome, which accommodates large and/or
multiple foreign inserts; (ii) the cytoplasmic replication mode, so that transcription and processing of vaccinia virus genes are carried out in the cytoplasm of infected cells by viral enzymes, thus obviating the necessity of foreign inserts containing splice or transport signals; and (iii) the experience with vaccinia for over 200 years in the vaccination against smallpox. Based on these attributes, prototype chimeric virus vaccines have been constructed against a variety of animal and human diseases. These chimeric vaccinia viruses include recombinants containing the genes encoding influenza virus hemagglutinin, hepatitis B surface antigen, HSV glycoprotein D, rabies glycoprotein, respiratory syncytial virus glycoprotein, the HTLV III envelope gene, Epstein-Barr virus membrane antigen gp340, secreted plasmodium antigen, vesicular stomatitis virus N and G proteins, Sindbis virus capsid and glycoproteins, and even the plant pathogen, tobacco itch virus.

Considering the long list of chimeric vaccinia virus recombinants and the broad host range of vaccinia virus which permits infection of a variety of species and cell types, caution is indicated prior to their use in human and veterinary medicine. Certification of the eradication of smallpox from Africa was signalled by a ceremony in Nairobi on October 26, 1979, two years after recognition of the last case of endemic smallpox in Somalia. In May 1983, the distribution of smallpox vaccine to coworkers was discontinued by the only active United States-licensed manufacturer. Vaccinia virus is not an innocuous agent. Vaccination with vaccinia virus can lead to abnormal skin eruptions, disorders affecting the central nervous system, and a variety of other less severe complications. A recent accidental human needle prick by a vaccinia recombinant expressing vesicular stomatitis virus antigens produced clinical symptoms. Vaccinia virus recombinants with reduced pathogenicity can undoubtedly be engineered. Yet, if hybrid vaccinia recombinants are to be used in humans, it would appear unwise to also use them in animals. It may be particularly unwise to use genes from zoonotic pathogens. In addition, even though immunization of cattle or foxes against rabies and vesicular stomatitis is important, what purpose is served by vaccinating these animals against smallpox? Or can a case be made for immunizing cattle with vaccinia to protect them against cowpox?

It is also relevant to establish for any veterinary vaccine whether spread may occur to human contacts of vaccinated animals. The possibility of recombination between indigenous poxviruses of the vaccinated species and the recombinant vaccinia strain must be considered. Comparative analyses of the proteins and genomes of orthopoxviruses isolated from animals and humans have shown that orthopoxviruses exhibit extensive serological cross-reactivity and DNA genome sequence homology. Recombinants between vaccinia and ectromelia viruses bearing the specific pathogenicity markers of both parents have been isolated. The possibility of recombination occurring in vaccines between chimeric vaccinia
GENETIC ENGINEERING OF VIRUS VACCINES

strains and cowpox and monkey pox, both pathogenic for human beings, cannot be ruled out.

It may be noted that analyses of cowpox outbreaks registered in several European countries have revealed an extremely wide range of virus pathogenicity including nine orders of mammals. Marennikova and co-workers state that serological and virological data support the hypothesis that wild rodents may be a natural reservoir of cowpox virus and that cowpox infections of humans have occurred without any contact with infected cattle in the United Kingdom and Poland. They conclude that surveillance of possible virus dissemination beyond its natural reservoir seems justified, since the spread of cowpox virus may result in further infection of man and other animals.

Another question that should be considered is whether recombinants between chimeric vaccinia strains and cowpox, monkey pox, or ectromelia may be more pathogenic than the parental viruses, or have altered pathogenicity. A precedent for this possibility exists. Malignant rabbit virus (MRV) is a natural recombinant of Shope fibroma virus (SPV) and rabbit myxoma virus. Only 10% of the nucleotide sequences of MRV are derived from SFV. Yet MRV has a broader host range and is more pathogenic than either parent. SFV routinely induces benign tumors that spontaneously regress in adult rabbits. Only in immunosuppressed hosts do the tumors progress into invasive fibromas. In contrast, MRV causes extensive immunosuppression which results in a fatal disseminated malignancy in immunocompetent animals.

Considering the preceding potential hazards, it would appear prudent to design species-specific hybrid virus vectors when they contain genes from other pathogens. Furthermore, the virus vector, per se, should be a safe and efficacious vaccine required to control a dangerous disease. Herpesvirus deletion mutants are excellent candidates for species-specific vectors of this kind. The herpesviruses have large genomes. Like the poxviruses, the herpesvirus genes encoding TK are selectable, but not essential for virus replication in cultured cells. As illustrated by the glycoprotein gI and gIII deletions in PRV, the glycoprotein gC and 0.76 to 0.79 map unit deletions in HSV-1, and the replication competent deletion mutant of herpesvirus saimiri, herpesvirus contain several nucleotide sequences which may be deleted from their genomes, without impairing replicative capabilities. These sequences may serve as sites of insertion of foreign genes. Herpesviruses exhibit enormous diversity in base composition, ranging from 33 moles % G + C in canine herpesvirus to about 70 mole % G + C in simian herpesvirus B. There is much less nucleotide sequence homology among the herpesviruses than the orthopoxviruses. Thus, recombination between hybrid herpesvirus vaccines and heterologous pathogenic herpesvirus field strains are less likely than for orthopoxviruses.

Species-specificity is not absolute. For example, IBRV has been isolated from pigs and can experimentally infect rabbits. However, disease signs
are mainly produced in cattle. EHV-1 has been isolated from cattle, but disease is principally produced in horses. PRV produces fatal infections in sheep and cattle, but the latter are dead-end hosts. Transmission is from pigs to other animals. Based on these observations, we are exploring the possibilities of constructing for pigs a chimeric PRV vaccine containing only gene inserts from other porcine antigens. The feasibility of this construction is indicated by reports that HSV-1 hybrid viruses efficiently express heterologous hepatitis B surface antigen and Epstein-Barr virus EBNA antigens. At Baylor College of Medicine, chimeric PRV strains have already been engineered to express foreign proteins, e.g., the E. coli β-gal gene and the HSV-1 TK gene.

Human and animal health can best be improved through the application of human intelligence and knowledge. The proper role for the scientists is to identify and solve concrete safety problems of the here and now. Society should not be preoccupied with hallucinations about unspecified hypothetical dangers that are unidentified and may or may not materialize at some unpredictable future time.

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GENETIC ENGINEERING OF VIRUS VACCINES

9. Rosen, A., Ernst, F., Koch, H.-G., et al. Replacement of the deletion in the genome (0.762-0.789 μ) of avirulent HSV-1 HFEM using cloned MluI DNA fragment (0.7615-0.796 μ) of virulent HSV-1 F leads to generation of virulent intratypic recombinant. *Virus Res.* 1986; 5:157-175.


Table 1. Body temperatures and survival of sheep intravenously immunized with tk⁻ PRV(BUK-dl3) or tk⁺ PRV(BUK-5)*

<table>
<thead>
<tr>
<th>Sheep</th>
<th>PRV strain</th>
<th>Body temperatures (°F) on postimmunization day:</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>ACC8</td>
<td>None (control)</td>
<td>94.0</td>
<td>93.5</td>
</tr>
<tr>
<td>ACBC</td>
<td>None (control)</td>
<td>94.8</td>
<td>ND</td>
</tr>
<tr>
<td>ACC1</td>
<td>tk⁻ PRV(BUK-dl3) **</td>
<td>92.0</td>
<td>105.9</td>
</tr>
<tr>
<td>ACC2</td>
<td>tk⁻ PRV(BUK-dl3) **</td>
<td>92.0</td>
<td>104.2</td>
</tr>
<tr>
<td>ACBD</td>
<td>tk⁺ PRV(BUK-5) **</td>
<td>104.0</td>
<td>106.0</td>
</tr>
<tr>
<td>ACCD</td>
<td>tk⁺ PRV(BUK-5) **</td>
<td>104.0</td>
<td>106.0</td>
</tr>
</tbody>
</table>


**Lambs were inoculated with about $8 \times 10^6$ PFU (2 ml) of either PRV(BUK-dl3) or PRV(BUK-5).

ND = Not done.
**Table 2. Challenge of vaccinated sheep with virulent tk\(^+\) PRV(Ind-F)**

<table>
<thead>
<tr>
<th>Sheep</th>
<th>Vaccine virus</th>
<th>Challenge virus</th>
<th>PRV neutralizing antibodies on postvaccination day:</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>ACC8</td>
<td>None</td>
<td>tk(^+) PRV(Ind-F)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ACBC</td>
<td>None</td>
<td>tk(^+) PRV(Ind-F)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ACBD</td>
<td>tk(^-) PRV(BUK-dl3)</td>
<td>tk(^+) PRV(Ind-F)</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>ACCD</td>
<td>tk(^-) PRV(BUK-dl3)</td>
<td>tk(^+) PRV(Ind-F)</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

*Sheep challenge-exposed intravenously to 10\(^6\) PFU (1 ml) of tk\(^+\) PRV(Ind-F).

\(+ = positive and \(= negative for PRV antibodies. Serology was carried out at 1:5 dilution of serum versus 100 tissue culture infectious doses of PRV(Ind-F).*
Fig 1 — Purification by Concanavalin A-agarose (Sigma) chromatography of $^3$H-mannose-labeled glycoproteins from rabbit skin (RAB-9) cells infected with TK + PRV(BUK-5). Cells were labeled from 5 to 24 hours after infection. Nonionic detergent extracts were prepared as described. Columns consisting of 2 ml bed volumes were equilibrated with washing buffer (0.15 M NaCl, 0.0625 M Tris-HCl, pH 7, 1 mM Ca$^{++}$, 1 mM Mn$^{++}$, and 1% Triton X-100). Then, 1 ml of $^3$H-mannose-labeled extract was applied. The flow rate was about 15 ml per hour, and 20 drop fractions were collected. The glycoprotein fraction eluted with 200 mM $\alpha$-methyl mannoside, designated E200, was saved for further study.
Fig 2 — $^3$H-mannose-labeled glycoproteins from PRV-infected RAB-9 cells after partial purification by concanavalin-A-agarose chromatography (see Fig 1), immunoprecipitation with different pig antisera, SDS PAGE, and autoradiography. These procedures have previously been described in detail. The total E200 fraction is shown in lane 1. E200 glycoproteins were precipitated by adding ammonium sulfate to 50% saturation and then redissolved in washing buffer. Immunoprecipitation was then carried out with pig sera and protein A as described (lanes 2 to 4, 6 to 8). The supernatant fluid from the ammonium sulfate precipitation was also analyzed (lane 5). For the experiments shown in lanes 6 to 8, the partially purified and concentrated E200 eluates were first treated with antisera WP2 (from pigs vaccinated twice with TK$^-$ (PRV(dlg92/dltk), and protein A, the precipitates were removed, and the samples were then treated with hyperimmune pig antisera 18705 (or WP2) and protein A (see text). The absorbed precipitates were then analyzed by SDS-PAGE.
In 1980 Reed reviewed at this meeting the sub-unit approach to the preparation of veterinary viral vaccines. My subject, Vectors of Animal Vaccines, is essentially an extension of his and describes technology developed since 1980.

By definition, a sub-unit vaccine is one which contains only those pieces of the microbe which are required for producing an immune response. Such products are produced by viral or bacterial means including (1) large scale production of the microbe followed by extraction and purification of the sub-unit of choice; (2) synthesis by chemical means where the sequence of antigenic site(s) are known; (3) biosynthesis, where the DNA encoded for the sub-unit is cloned and inserted into a plasmid which is then put into a host where the protein is expressed. Such microbes can be propagated in large volume containers for mass production of the sub-unit immunogens; and (4) DNA or genes encoded for the protein of choice can be inserted into a virus vaccinia vector such as other viruses and bacterial host such as Salmonella which then serve as a vector for the protein or sub-unit. It is these latter methods of producing immunogens which are included in this review.

**Live Recombinant Vaccines as Vectors of Antigens**

*Vaccinia Virus*—Recently at least two different groups led by Moss and Paoletti have combined vaccinia virus, used to immunize against smallpox, with genetic material from a variety of different viruses, some of which are listed below. These are referred to as live recombinant vaccines. The hybrid vaccinia virus contains the gene for the immunogen of choice, and it stimulates protective antibodies against the parent microbe when injected into animals. Sites on the genome of the vaccinia virus have been identified where foreign DNA can be inserted without interfering with the replication of the virus. The DNA is introduced in a way that the protein encoded by the new DNA is produced along with normal vaccinia proteins during the growth cycle of the virus. The foreign genetic material is inserted into a plasmid specially engineered with flanking vaccinia sequences. Cells are then infected with regular vaccinia virus and the engineered plasmid is introduced into the cells. During replication in the cell, the foreign gene recombines with matching gene sequences in the vaccinia virus. The hybrid viruses are then identified and are recovered for use in the immunization. When hybrid viruses are inoculated into animals a local infection is produced to vaccinia and antibody is produced to the
protein encoded by the foreign gene.

Genes expressed by vaccinia virus include those of at least RNA and DNA viruses and protozoa. Vaccinia virus has already proven itself through eradicating smallpox and its properties make it an ideal vector for mass immunization campaigns against other diseases of man and animals. The prospects offered by this new technique for developing inexpensive vaccines which do not require refrigeration are exciting. Vaccinia virus can produce both humoral and cell-mediated immune responses. The optimism that this technology will lead to inexpensive and effective vaccines against a variety of major diseases must be tempered with concerns which stem from the known adverse reactions to vaccinia virus which were well documented during the smallpox eradication program. Thus, before the general use of recombinant vaccinia virus vaccines is possible, the several important issues relative to efficacy and safety must be resolved. In Table I, Bachrach lists some of the advantages and disadvantages of vaccinia vectored vaccines.

The wide host range of vaccinia could allow it to be a delivery system to a variety of species of animals as well as man. Many recombinant vaccinia viruses have been constructed expressing antigens for diseases of animals. Some include rabies virus glycoprotein gene, swine influenza haemagglutinin, vesicular stomatitis virus and Rift Valley fever (Table II).

The efficacy of the vaccinia recombinants will depend upon several additional lines of investigation which should be conducted.

1. Determine the best ways for inserting the foreign genes into the virus to obtain maximum production of the protein.
2. Establish reliable markers for virulence in the species for which the vaccine is intended.
3. Observe results of inoculation of animals for signs of illness, viremia, transmission and protection.
4. Study the possibilities of inserting genes encoded for several different disease causing organisms to determine the possibilities of vaccinations against several diseases by a single recombinant vaccine.
5. Vaccinia virus has been produced traditionally in calf lymph. This method may still be acceptable for use in animals; however, most authorities probably would consider such a product unacceptable for man. Therefore, vaccine for man must be produced in tissue cultures using currently acceptable laboratory standards and tested to determine its usefulness.

The USDA and other groups, especially including regulatory officials, can play an important role in encouraging and supporting investigations of the type listed above. Assistance will also be required for formulating guidelines and listing the requirements for standardization, control and
field use of any new vaccines developed by this technology. Research is currently underway in many laboratories on the use of vaccinia as a vector and some of the results are very encouraging. Requests for licenses are likely.

Other Virus Vectors

In addition to vaccinia, other host specific pox viruses are being investigated as vectors. Boyle has identified and cloned the thymidine kinase gene from fowl pox virus with the view of TK-fowl pox virus as a delivery vector for poultry. In this study the vaccinia virus was used as a selection and cloning vehicle to identify and characterize a fowl pox virus genome fragment. The results indicated that vaccinia can be used to identify and clone genes of other pox viruses. The orthopox virus that causes orf has also been suggested as a vehicle for delivering vaccinia to sheep. One group in Europe is working on sheep pox virus, which is host specific to sheep and goats. The particular construct being attempted is to introduce genes encoding the HA and F proteins of rinderpest virus. It has been demonstrated for other Paramyxoviridae that these two polypeptides are essential as immunizing antigens; since these genes have been cloned for measles virus, it is likely that they can be used as probes for other mobilli virus, such as rinderpest, canine distemper and peste des petites ruminant to select the corresponding Ha and F genes for these viruses.

Other viruses mentioned as vectors include herpes viruses, SV40 and adenovirus. Retroviral infection of early mouse embryos have been used first by Jaenisch and is being used experimentally to introduce genes into the germ line by way of injection prior to implantation. Thus far, this technology has been used only for insertions into mouse embryo, but work with swine and poultry and possibly other species is being attempted. While most studies with retroviruses have been aimed at introduction of genes controlling growth, location and disease resistance, as more information is developed, other genes controlling more complex systems such as a wool growth, milk composition and genetic defects may be attempted.

What about the risks of gene insertion by retroviruses? Every procedure carries the potential for harm. It is not entirely certain whether the insertion of foreign DNA into a cell will be detrimental to the cell. The concern is that alteration of the genetic makeup of a cell might, over time, transform it to malignancy. The idea is to modify the vector in such a way that genes carried by vectors are controlled by regulating sequences other than those of the virus. In summary, it must not cause greater harm than the benefit it produces.

Insect Viruses

Baculovirus of insects is also being used for generation of recombinant products. While this is not a method of vectoring genes directly into animals, it is nevertheless a use of virus as a vector into another host for
the production of an antigen which can be formulated into a vaccine.

In this technology a cell line from the pupal ovarian cell of the moth *Spodoptera frugiperda* is infected with virus carrying the foreign gene. These cells secrete recombinant products complete with post-translational modification including phosphorylation and glycosylation. Mammalian cells offer the same advantages, but do not produce as much protein. The baculovirus system has been used to produce human B-interferon, human interleuken 2, human c-Myc protein, haemagglutinin from influenza virus, hepatitis B antigen, malaria Sporozoite antigen and protein from segments 2 and 3 bluetongue virus of sheep. Evaluation of the biological properties of the products against bluetongue virus are currently underway.

The baculovirus system is easily engineered and a high rate of synthesis is achieved. The productivity of the system is due to the efficiency of the viral promoter of the gene encoding the protein polyhedron, the sole component of the crystalline matrix that acts as a protective shield for viral particles existing outside the insect host. Caterpillars eat the matrix and release the particles which then temporarily suspends polyhedron synthesis. When the caterpillar is near death, the virus resumes matrix protein production until roughly 20% of the larval host consist of polyhedron. The products of this system have not yet been fully evaluated.

**Bacteria as Vectors**

Strains of *Salmonella typhi* constructed in such a way they do not revert to virulence have been produced and used as candidates for orally administered live vaccines. Such attenuated strains have been produced by introducing genetically defined, deletion mutations into genes encoding enzymes which play essential roles in particular metabolic pathways. Examples are the *aro* genes required for the synthesis of aromatic metabolic pathways. Since the supply of some key aromatic compounds is limited in mammalian hosts, the growth of *Salmonella* mutants lacking genes for these compounds is restricted and enables the host to control infection by these bacteria. Animals vaccinated with such products are protected against infection with virulent *Salmonella*. After infection with the altered strains the host macrophages ingest the bacteria where they continue to reside and stimulate elevated levels of serum and gut anti-*Salmonella* antibodies. DNA from *E. coli* has also been introduced into altered strains of *Salmonella* causing protective levels of antibody against *E. coli*. At present the feasibility of using *Salmonella* as a carrier of heterologous antigens to the immune system is being evaluated.
### Table 1. Pros and Cons of Vaccinia Virus Vectored Vaccines

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
</table>
| 1. V³ eradicated smallpox  
   a. used in military recruits, 17 countries.  
   b. genetically stable  
   c. T-cell immune response | 1. Weak initial replication of V⁴ vs. wild type  
   a. Wistar rabies V⁴ required virulent Copenhagen V³ vector not used in U.S.A. NYBH strain would have to be used in U.S.A.  
   b. No panacea. Polio doesn’t work and no Abs in calves after revaccinations V⁴/HBsAg gene  
   c. vaccinia virus/VSV G gene recombinant accident in human (Jones)  
   d. further testing in animals and humans needed |
| 2. V⁴ research successes  
   a. individual inserts  
   b. multiple inserts to 25k bp | 2. V⁴ revaccinations  
   a. several unanswered questions  
   b. evidence for immunosuppression  
   c. questionable efficacy in diseases with short durations of immunity, as in FMD |
| 3. Easy production  
   a. V³, yes  
   b. V⁴, probably  
   c. V⁴ alternate in vitro production for purified protein vaccine  
   d. V⁴ requires no adjuvant  
   e. freeze-dry for 1 year at 38°C | 3. Environmental release of replicating genome  
   a. allows contact infection of immunodeficient individuals  
   b. possible virulence for non-targeted hosts  
   c. possible recombinations with animal or avian pox viruses to virulent or tumorogenic forms (as in myxoma and fibroma) |
| 4. Easy application  
   a. simulates live vaccines  
   b. single dose  
   c. biforciated needle  
   d. multi-dose jet gun | 4. Possible retention of V³ side effects  
   a. disseminated vaccinitis, 1/300,000 incidence  
   b. encephalitis |
| 5. Eliminates large-scale animal cell and bacterial cultures and protein purification equipment |  |
CALLIS

c. death, 1/1,500,000 incidence
d. initial and revaccination
scarrings

5. Question use of human virus
vector for animal virus vac-
cines

6. Dangerous for immuno-
suppressed individuals in
prodromal stages of disease
(e.g., early AIDS)

7. Variola virus will be destroyed
world wide October 1987,
with possible exception of one
WHO site and one U.S.S.R.
site

Table 2. Experimental Vaccinia Virus Vectored Vaccines in Animals

<table>
<thead>
<tr>
<th>Virus/Disease</th>
<th>Species</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vesicular stomatitis</td>
<td>cattle</td>
<td>Yilma⁷</td>
</tr>
<tr>
<td>Rabies</td>
<td>raccoon</td>
<td>Wiktor⁵</td>
</tr>
<tr>
<td>TGE</td>
<td>rats</td>
<td>Smith⁸</td>
</tr>
<tr>
<td>Rift Valley fever</td>
<td>sheep</td>
<td>Dalrymple¹⁰</td>
</tr>
<tr>
<td>Swine influenza hemagglutinin</td>
<td>(swine, sheep and poultry)</td>
<td>Boyle⁹</td>
</tr>
</tbody>
</table>

REFERENCES

VECTORS OF ANIMAL VACCINES


10. Dalrymple, Joel, Personal Communication.


REPORT OF THE COMMITTEE ON BIOLOGICS

Chairman: Dr. R. W. Loan, College Station, TX
Vice Chairman: Mr. M. Huff, Denver, CO

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Fifty-one Committee members and other interested persons attended the Biologics Committee meeting on Thursday, October 23, 1986. Adoption by USAHA of the Committee’s 1985 resolution in support of the Melcher amendment (1985) to the Virus-Serum-Toxin Act of 1913 was reviewed. The Chairman announced that persons wishing to be appointed to the Biologics Committee should indicate this on the attendance roster or directly to the Chairman. Appointments will be recommended with regard to balance between biologics industry, producer, government and academic representation.

Dr. David Espeseth described current activities of Veterinary Services in licensing products resulting from biotechnology. The role of the new Biotechnology Science Coordinating Committee was described. Bioengineered products will be assigned to one of three categories for licensing considerations:

Category 1 — Non-living products resulting from biotechnology
Category 2 — Gene-deletion products or products with simple insertions
Category 3 — True recombinant products such as virus-vectored vaccines

Category 1 products will be licensed by conventional procedures. Category 3 products will be licensed according to new procedures for bioengineered products. Category 2 products may eventually be handled as Category 1 products. Several bioengineered products in Category 1 and one product in Category 2 have been licensed. Dr. Espeseth also described progress in rule-making under the 1985 Melcher amendment to the Virus-Serum-Toxin Act of 1913.

Dr. R. L. Levings outlined testing procedures for bioengineered products by the National Veterinary Services Laboratory. It is planned to exten-
sively supplement testing procedures currently in use to meet testing requirements for bioengineered products.

Dr. Saul Kit, Baylor College of Medicine, discussed gene-deletion virus vaccines. He indicated several new products of this type have been patented. He also spoke at considerable length about virus-vectored vaccines. In regard to the use of vaccinia virus as a vector, he noted the genetic similarities of the different mammalian pox viruses. He further suggested that these similarities might facilitate virus hybridization in nature with possible increases in virulence of the vaccinia vector for animals and man. He then presented reasons for believing that herpesvirus vectors would be safer than vaccinia vectors. The basis for this is the genetic dissimilarity of the various herpesviruses which would limit hybridization. The full text of Dr. Kit's presentation to the General Session is reported elsewhere.

Dr. J. L. Callis presented an overview of vectors of animal vaccines. Numerous vectors have been used experimentally with success. While the feasibility of vectors has been demonstrated, determination of the most useful and safest vectors has not been made. The full text of Dr. Callis' presentation to the General Session is reported elsewhere.

Dr. E. E. Widman reported on vaccination of calves in New Zealand with an experimental vaccinia virus-vectored Sindbis virus vaccine. Antibody against Sindbis virus was produced following multiple injections.

Dr. Janis McMillen discussed risks from bioengineered products. Current conventional products are not risk-free. It follows that bioengineered products cannot be expected to be entirely risk-free. However, properly developed bioengineered products of the future will combine low risks with high benefits for society. The full text of Dr. McMillen's presentation is published herein.

The Committee recommended resolutions on approval of official diagnostic tests and commending USDA-APHIS for its work and interest in the field of animal biotechnology for approval by USAHA.

RISKS OF BIOENGINEERED PRODUCTS

Janis McMillen, Ph.D.
SyntroVet Incorporated

The subject of "risks associated with using bioengineered products" has received considerable attention over the last several years and has been discussed and written about by many diverse groups. There is little doubt in the minds of many people that the power of molecular biology is presenting science and industry with many new opportunities for developing vastly improved and safer products than currently exist. At the same time there are those who question the "new" technology, their concern being founded at least in part by a lack of understanding of the science, and in some cases a feeling of greater comfort in staying with the status quo.

It is my intention to put these hopes and concerns into a framework that
will allow us to view the emerging new products and their base technology alongside current products and the scientific technology from which they were derived.

If we allow history to guide us, we will see that we are dealing with an evolving technology, an evolving application of this technology into new products and, not least important, an evolving set of regulatory requirements to address the changes in products and technology. I think it will become apparent that in fact “molecular biology,” “recombinant DNA technology,” “genetic engineering,” or whatever we choose to call it, is not so much a new and novel science as it is an extension of technology that we have been using, but one that offers us a more precise and directed approach to vaccine development.

In the early 1950’s, when the veterinary industry was using formalin or phenol inactivated tissue vaccines, the structure of DNA and the “one gene—one enzyme” theory were being discovered. In the 1960’s the veterinary industry was taking advantage of the newly discovered cell culture technology to produce improved vaccines. At the same time, specific genes were being identified in segments of chromosomes and restriction enzymes were discovered. The full impact of this latter discovery was realized in the 1970’s when it became apparent that these restriction enzymes, or “genetic scissors,” could be used with a high degree of accuracy to remove portions of genes or entire genes from any DNA. The power of monoclonal antibody technology developed in the 1970’s, in part paved the way for development of subunit vaccines by allowing a more precise identification of immunizing proteins on surfaces of viruses and bacteria. Today, in the 1980’s, we continue to extend and apply these developing technologies to new and improved products.

If we examine current vaccines and the technology used to develop these vaccines, it will become apparent that our basic understanding of the science of these products is incomplete. For the sake of the ensuing discussion, I will use viral vaccines as the illustration; however, most of what I will say applies also to bacterial vaccines.

Populations of viruses that exist naturally in the environment are heterogeneous. That is to say, viruses recovered from tissues of a clinically ill animal represent a mixed population of virulent and avirulent viruses, with the virulent organism representing a dominant population. To develop safe, effective modified live vaccines, historically we have done one of several things. We have propagated a virulent population of viruses in an alternate host, such as chick embryos, mice or other laboratory animals, or multiple passages of viruses have been made in cell culture. In either case, the viruses were blindly passaged until an assessment of their performance in the host animal indicated that a predominantly attenuated population of viruses had been selected. Another method for obtaining attenuated viruses from a virulent population has been to expose virulent
viruses to a chemical mutagen, then apply a selective pressure to select the mutagenized virus population. This is best exemplified by temperature-sensitive mutants, viruses that are selected because they replicate better at lower temperatures. The primary application of this technology has been in the area of respiratory vaccines, selecting viruses that replicate preferentially in the cooler temperatures of the upper respiratory tract.

In any of the above cases, the viruses used for vaccines are selected based on biologic or phenotypic properties. We have had very little if any knowledge of what was happening at the genetic level. We have all recognized the major benefit associated with the use of modified live vaccines—a more efficacious product. However, we have also recognized the risks associated with the use of live vaccines, such as reversion to virulence and the potential presence of adventitious agents being carried in the cell substrate or seed virus. Over the years, those risks have been identified and USDA has developed the appropriate regulations to assess such risks in a reasoned manner.

The use of inactivated vaccines is not without risk either. We generally consider inactivated vaccines to be safer but less efficacious than modified live vaccines. However, the choice of inactivating agent is very critical, not only in terms of preserving immunogenicity of the key antigen but in ensuring complete inactivation of what might otherwise be a virulent organism. Recognizing this risk, it is now required to establish the inactivation kinetics for each organism and to monitor these kinetics for each batch of vaccine being prepared.

As the technology has advanced, we now have the capability of producing subunit vaccines. Such vaccines may be derived in one of two ways. In the first instance, the key immunizing antigen is extracted, usually by chemical means, from the virus itself and after further purification the extracted antigen is used as a vaccine. In another approach, the gene coding for the desired antigen is encoded in \textit{E. coli} or yeast and is expressed in these microorganisms. In either case, a considerable amount of purification is required. The risks associated with these vaccines are twofold. In the first case, one must be certain there is no residual live virus remaining in the vaccine preparation., In the second case, the desired immunogen must be purified away from other materials in the expression vector and in the case of \textit{E. coli}, the presence of endotoxin is a concern. These risks are recognized by scientists and by the industry and considerable effort is being put forth to perfect “downstream processing.”

The veterinary biologics industry has been quick in most instances to take advantage of developing technologies to bring about product improvements. At the same time, the industry and USDA have worked together to adapt existing regulations and guidelines to address new risks as they are identified.

We now have the opportunity to extend our technology even further and to develop superior products. The superiority of bioengineered products
lies in the basic molecular understanding we now have of viruses and bacteria. We have the ability to identify the genes responsible for imparting virulence and those coding for protective antigens. With the use of restriction enzymes, we can cut out the virulence genes, leaving an attenuated organism that still has its full immunogenic potential. Because of the size of the deletion being made in the DNA, the chances of a deleted virus reacquiring the entire virulence gene and reverting to a virulent form are negligible.

Today's technology has taken us out of the "black box" of virus manipulation into an enlightened arena whereby predictability of performance is far more certain and where desired features can be engineered into microorganisms. Armed with our current knowledge, we can identify with greater accuracy the risks associated with this technology. If we are willing to break down the risks into manageable components, we can take reasonable steps to address each concern. It is important that we remain flexible in our approach to managing the risks and that we separate what is known and unknown from what is feared. It is equally important to strike a balance between encouraging the science and addressing the concerns, and between testing bioengineered products and having products to sell.

I am confident that the scientific community, the biologics industry and USDA will continue to cooperate in providing superior products to the customer.
VETERINARY MANAGEMENT OF AN ARTIFICIAL INSEMINATION CENTER CONTAINING BLUETONGUE SEROPOSITIVE BULLS

Donald R. Monke, D.V.M.
William D. Hueston, D.V.M., M.S., Ph.D.
Jay W. Call, D.V.M., M.S.

SUMMARY

Regular serologic and virologic tests for bluetongue virus were conducted at approximately six month intervals on bulls residing in a small artificial insemination center in northern Utah. Both bluetongue seropositive and seronegative bulls resided in the herd. Of 367 bluetongue agar gel immunodiffusion tests conducted on 71 bulls and two steers during the 4½ year study period, 201 test results (55%) were positive. Concurrently, whole blood was tested for detectable bluetongue viremia and all results were negative. This study indicates that positive bluetongue serology is poorly correlated to bluetongue viremia and suggests that persistent bluetongue viremia is an uncommon event. Because bluetongue seronegative animals did not seroconvert or become viremic, the study also suggests that artificial insemination centers may be located in certain areas within bluetongue enzootic regions with minimal risk of bluetongue transmission.

INTRODUCTION

Research in the past decade has significantly increased our knowledge of bluetongue virus (BTV) epidemiology. The primary mode of BTV transmission is a biologic vector — biting midges of the genus Culicoides. A secondary, direct mode of transmission has also been established involving seminal transmission of BTV. Bluetongue virus has been isolated from bovine semen. In utero inoculation of BTV-contaminated semen has resulted in BTV infection of some inseminated cattle.

This understanding of BTV epidemiology has caused concern within the artificial insemination (AI) industry regarding the frequency of and circumstances surrounding the seminal transmission of BTV. It has also increased regulatory constraints concerning the international trade of bovine semen. These facts are particularly pertinent regarding the maintenance and use of bluetongue (BT) seropositive bulls as AI sires. Subsequently, three issues requiring clarification have been identified; 1) the prevention of seminal transmission of BTV; 2) the prevention of BTV transmission among bulls maintained for AI; and 3) the development of

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diagnostic tests and procedures to facilitate the above.

Research has indicated that positive BT serology is poorly correlated to BT viremia and seminal shedding of BTV. Furthermore, it has been demonstrated that BT contamination of semen occurs only during the period of viremia and then only sporadically. It has also been suggested that BT-seropositive bulls do not have long term seminal shedding of BTV. Therefore, the premise has evolved that BT-seropositive bulls may be safely used as AI sires if they are proven to be aviremic for BTV.

Using this information, several AI centers have established satellite AI centers in BTV-enzootic regions of the United States. Their purpose is to provide housing and semen collection facilities for genetically superior BT-seropositive bulls. This presentation reviews the BTV test histories of animals that have resided at one of these satellite AI centers.

MATERIALS & METHODS

The AI center where this study was conducted is located in northern Utah at Logan. The elevation of Logan, Utah is 4,535 feet. The AI center has a capacity of 40 animals. Bulls are housed individually with indoor pens and outside runs provided for each. Bulls with BT-seronegative histories as well as BT-seropositive bulls resided at or entered the AI center.

The study reviewed BT serologic and virologic test results conducted from January 1, 1982 through June 30, 1986, a period of 4½ years. During this time 10 complete herd tests were conducted. An average of 37 animals were examined per herd test. A total of 73 individuals resided in the AI center for varying lengths of time during the study period—71 bulls (3 Brown Swiss, 10 Guernsey, 35 Holstein, 13 Jersey, 7 Angus, 2 Horned Hereford, 1 Polled Hereford) and two steers. Most of the animals were able to be tested repeatedly; 45 bulls and the two steers (64%) resided in the AI center for four or more herd tests.

Serology: Serologic tests for BT using the agar gel immunodiffusion (BT-AGID) test were conducted on every animal at each herd test. The Ohio Department of Agriculture Laboratory in Reynoldsburg, Ohio conducted the BT-AGID test for the January 1982 herd test; the Central Animal Health Laboratory (CAHL) in Madison, Wisconsin performed the BT-AGID tests for the July and November 1982 tests. Thereafter, the Diagnostic Laboratory at Utah State University, Logan, Utah conducted the BT-AGID tests at six month intervals. Bluetongue serum neutralization (BT-SN) tests conducted on selected bulls were performed at the CAHL.

Virology: All animals present in the AI center were examined for BT viremia at 8 of the 10 herd tests. Ten ml whole blood was collected from each animal and placed into sterile, heparinized blood collection tubes. The blood was chilled and sent by overnight express delivery to the
ARTIFICIAL INSEMINATION

prearranged laboratory. Additional processing of the blood samples was conducted at the laboratory per their standard BTV testing protocol. The prepared specimens were inoculated into embryonating chicken eggs by the intravenous route; standard cell culture protocol for BT virus isolation was used to further establish the BTV status of the specimen.

Semen was not used as the test specimen in this herd because of the inherent toxicity of bull semen for common BT virus isolation systems. It was considered that virologic testing for BTV would be more sensitive if blood was the specimen rather than semen.

Virologic tests were conducted at the National Veterinary Services Laboratory, Ames, Iowa for herd tests conducted in January 1982, November 1982, and May 1983. Thereafter, tests for BTV were conducted semi-annually at the Colorado State University Diagnostic Laboratory.

RESULTS

During the 4½ years of the study, 367 BT-AGID tests were conducted on 73 animals; 201 tests (55%) were positive. During this same time interval 271 whole blood samples were tested by virus isolation technique for BTV; all results were negative. Therefore, none of the bulls exhibited detectable BT viremia during the 4½ year period of the study, even though most bulls were tested repeatedly.

Monitoring the potential for transmission of BTV among cattle within the AI center was possible because the resident BT-seronegative bulls and steers acted as susceptible "sentinel" animals. None of the BT-seronegative cattle seroconverted during the course of the study and none exhibited detectable viremia. Another method for describing the risk of potential transmission of BTV among bulls in the AI center was to determine the cumulative number of arthropod vector seasons during which BT-seronegative bulls resided at the AI center. Bluetongue seronegative animals were cumulatively exposed to 63 BTV vector seasons, during which none of the BT-seronegative cattle seroconverted and no BTV was detected. Consequently, BTV was not transmitted from the BT-seropositive bulls to the BT-seronegative cattle within the AI center, nor from possible exposure by infected vectors from the local geographic region.

Categorization of the animals by their individual histories of BT-AGID results revealed that 25 bulls and two steers (37%) were consistently BT-seronegative and 27 bulls (37%) were consistently BT-seropositive. Nineteen bulls (26%) demonstrated inconsistent serologic results. Seven of these bulls had only one BT-AGID negative response. Seven others had undulating BT-AGID responses, that is, their BT-AGID results alternated between positive and negative several times. Interestingly, five bulls that had a history of BT-seropositive responses seroconverted to negative during the course of the study and remained BT-AGID negative for three or more consecutive tests conducted at six month intervals.
Bluetongue SN tests, conducted on five of the twelve bulls that either seroconverted to negative or had undulating serologic responses, were negative with the exception of one bull who responded to BT serotype 17. Bluetongue SN tests conducted on 17 bulls categorized as consistently BT-AGID positive revealed 15 (88%) to be BT-SN positive to one or more serotypes. The BT serotype most commonly identified was serotype 11 (10 bulls). Four bulls responded to two or more BT serotypes.

**DISCUSSION**

The results of this study support the work of others which indicate that positive BTV serology is poorly correlated with detectable BT viremia. In this study this was pertinent to BT group specific serologic tests (BT-AGID) as well as to BT serotype specific serology (BT-SN). Although 46 of 71 bulls (65%) exhibited BT-seropositive responses, none of these bulls exhibited BT viremia. When this information is applied to the reports that seminal contamination occurs only during the period of BT viremia then this study also supports the contention that chronic seminal shedding of BTV is not a common event in bulls previously exposed to BTV.

During the past decade, the AI industry in the United States has witnessed the emergence of significant international concern regarding BTV. A wide variety of BT regulations and proposed requirements have been received from numerous countries. Some of these regulations have been practical and workable; others, based on unrealized fears of the disease, have been excessive, prohibitive, or have made the export of bovine semen difficult and costly.

The reported evidence of BTV having been isolated from bovine semen has, understandably, led certain countries importing semen from the United States to require that the donor bull and/or AI center be “blue-tongue negative.” The BT complement fixation test and, more recently, the BT-AGID test have been used to certify individual bulls and/or herds “free of BTV.” This serologic approach to export compliance has its merits for qualifying BT-seronegative donor bulls and/or herds located in BT non-enzootic regions of the United States (i.e., the northeastern and north-central states). On the other hand, the reliance on BT serologic tests for regulatory compliance has perhaps caused many to consider that BT-seropositive bulls are unfit for AI service despite the fact that much of the research suggests otherwise. Research suggests that BT viremia following exposure is short-lived, that seminal shedding of BTV occurs only during the viremic stage, and that seminal shedding and BT viremia are both poorly correlated to positive BT serology. These concepts have provided a framework upon which practical BT regulations can be developed.

The nature of BT disease and its diagnostic complexities do not necessarily lend themselves to simple regulation. However, the research reviewed and the information reported herein suggest that for the international exchange of germplasm, BT-seropositive bulls should not be
ARTIFICIAL INSEMINATION

summarily dismissed. Diagnostic tests to determine detectable BT viremia provide an appropriate alternative for identifying those BT-seropositive bulls that may qualify as AI sires relative to the non-transmission of BTV by AI. Furthermore, appropriate testing may demonstrate that certain AI centers located in BT-enzootic regions may be in a specific geographic area where minimal risk of BTV transmission exists.

As long as cattle are bred and reared in BT-enzootic regions of the United States, genetically superior cattle will be identified that are BT-seropositive. When properly managed, however, semen from BT-seropositive bulls can be safely used for breeding purposes.

REFERENCES

STUDIES ON THE CONTROL OF BOVINE LEUKOSIS VIRUS INFECTION IN THE NORTHWESTERN UNITED STATES

James F. Evermann, Ph.D.*
Ronald F. DiGiacomo, V.M.D., M.P.H.
Erich Studer, D.V.M.
Robert L. Darlington, D.V.M.
Sharon Hopkins, D.V.M.

ACKNOWLEDGMENTS

The authors would like to express their appreciation to Dr. Steve Parish, Dr. Alan Sparling, Dr. Reilly Glore, Dr. William Davis, Dr. Saralyn Smith, Ms. Alison McKeirnan, Ms. Lorraine Tanaka, Mr. John VanderSchalie and Mr. Dave Thacker for their cooperation in the sampling and testing of dairy cattle. We would also like to acknowledge the support provided by the Washington State Veterinary Medical Association and the Washington State Dairy Products Commission.

INTRODUCTION

1. The Infection and Disease

Bovine leukosis virus (BLV) has been recognized for almost 20 years. Prior to that time, the disease manifestation of the virus infection, referred to as bovine leukosis, or bovine lymphosarcoma, had been described in Europe at the turn of the century. It is important to distinguish infection from disease when talking about BLV since the two are not necessarily the same. Figure 1 presents a schematic that we are currently following in studying the different stages of BLV infection and disease. The virus is known to be spread predominately in blood since it is closely associated with the lymphocyte fraction of white blood cells. Infection can occur either vertically, i.e., from dam to calf in utero, or horizontally, i.e., cow to calf or cow to cow. Once infection takes place, the virus replicates and infects other lymphocytes in the animal. Concurrent with the multiplication of virus, the animal’s immune response is alerted and antibodies are formed to the virus. Once antibodies are detected, the animal is considered to be BLV seropositive (serum antibody positive).

At some time following infection (3 months to 3 years) and the development of antibodies, the animal may enter a precancerous state wherein there are no apparent clinical signs of the disease, but the lymphocyte population increases. Approximately 30% of the animals that are BLV seropositive progress on to become persistently lymphocytotic.
CONTROL OF BOVINE LEUKOSIS VIRUS INFECTION

The last state is the clinical disease phase during which time the cow develops clinical signs of illness due to tumor development. Depending on where the tumor is located, the clinical signs may range from protrusion of the eye, to a displaced abomasum.\(^{19}\) On some occasions, the tumor is not discovered until after the animal is culled from the herd for doing poorly and it is then identified at the rendering plant and condemned. Approximately 5% of the animals that are BLV seropositive go on to form tumors.\(^{7,19}\)

2. Economic Consequences

Cows that are culled from the herd because of tumors represent one form of economic liability.\(^{12,21}\) If the infection rate (number of BLV seropositive cattle) is low in a herd (<20%), the direct loss from those animals with tumors is not too great. However, if the infection rate is higher, the proportion of BLV seropositive animals that go on to form tumors is also higher.\(^{7}\) Unfortunately, unless a herd is being routinely tested for BLV antibodies, it is likely that the infection rate will increase steadily over time until 60 to 80% of the herd becomes infected. At this point, it then becomes very difficult to control the disease since the infection is considered endemic (greater than 60% infection rate).

The other economic consequences of BLV infection are the constraints placed upon the movement of cattle between farms, states and countries that import cattle by-products.\(^{9,10,12,13}\) A number of European, Latin American, and Oriental countries have national eradication programs that require cattle being imported be BLV seronegative and be from BLV-free herds.\(^{10,12,13,16,18}\)

3. Current Findings on Virus Spread

Prior to 1980, the natural spread of BLV was considered to occur predominantly by horizontal transmission (80%) in contrast to vertical transmission (20%).\(^{7}\) These percentages are still considered to be valid except in herds in which a genetic predisposition to BLV infection has been reported.\(^{1,2}\) Since the majority of infections occur after birth, it has been of utmost concern to identify those procedures which contribute to the spread of BLV on-the-farm. See Figure 2 for a diagram of BLV transmission.

It has been well documented that BLV is closely associated with blood.\(^{6,7,11,12,22}\) Therefore, our approach has been to systematically review those on-the-farm procedures that may be associated with BLV seropositive animals. Our studies have shown that small amounts of blood (0.001 ml, 1/10th of a drop of blood) when given intramuscularly, intravenously, subcutaneously or intradermally all result in an animal becoming BLV seropositive within 14 weeks.\(^{6}\) These results by themselves indicate that BLV is very infectious if introduced into the body by a combination of blood-contaminated instruments and breaks in the skin or by inadvertent inoculation.
These observations have been further substantiated by studies which have shown that gouge dehorning and ear tattooing were major factors in the spread of BLV in calves.\textsuperscript{5,11} Routine disinfection of dehorning and tattooing devices should be of great benefit in reducing the spread of BLV in some BLV-infected herds.

Recent studies with embryo transfer (ET) and artificial insemination (AI) have indicated that these techniques for preservation of valuable gene lines and genetic qualities can be regarded as safe and not a means of BLV spread.\textsuperscript{4,13}

**MATERIALS AND METHODS**

**Animals**

Holstein cattle of varying ages were sampled for the presence of BLV antibodies by the agar-gel immunodiffusion (AGID) test (Leukassay-B, Pitman-Moore Inc, Washington Crossing, N.J.).

**RESULTS**

**Seroprevalence Study**

Over the past decade 2,269 cattle have been tested for the presence of BLV infection by the AGID test. These results are summarized in Table 1. There have been 3 surveys conducted, 1977–79, 1980–83 and the most recent, 1984–86. The results indicated the 533 animals were seropositive, for an overall seroprevalence rate of 23%.

**Determining Farm Practices Which May Spread Bovine Leukosis Virus**

On the basis of previously published information our hypothesis for the proposed mechanisms of BLV spread on-the-farm is presented in Figure 2.\textsuperscript{7,14,15} The transmission of BLV is divided into 3 time periods. The first period of time is projected to only last a few days and represents the time immediately after initial infection of a BLV seronegative animal. It is projected that BLV may have a cell-free transmission period during this time when it could be spread in secretions from the animal prior to the development of circulating antibodies and stimulation of a cell-mediated immune response.

The second period of time is proposed to represent the longest time interval and would be characterized by a cell-associated (B lymphocyte) viremia. Any spread of infected lymphocytes by blood-contaminated instruments, blood-sucking insects, common needles, etc., would conceivably serve as a mode of BLV spread to susceptible cattle.

The third and last phase is projected to occur during pregnancy when BLV is released from maternal lymphocytes at the placental barrier and crosses as a cell-free virus to the fetus. After infection of the fetus the virus infects the fetal lymphocyte and becomes cell-associated once again (in utero infection).
CONTROL OF BOVINE LEUKOSIS VIRUS INFECTION

Our studies have been aimed at the second period of time and endeavoring to reduce blood-borne spread of BLV by changing management protocols. Our results to date substantiate the recommendations made by Ruppanner et al (Table 2).

DISCUSSION

Over the past 10 years our studies have been directed at determining the following: 1) the seroprevalence of BLV infection in the northwestern United States; 2) establishing guidelines for control of the spread of BLV on-the-farm; and, 3) investigating different modes of virus transmission which may have an impact on the spread of BLV. We have predicated our research efforts on what we consider to be a significant problem. The significance of BLV infection is best summarized by quoting from Miller and Van Der Maaten:

To summarize our view of the significance of BLV to the dairy industry, at present the primary concern is the high prevalence of virus infection in the United States and the consequent limitation on cattle exports. The economic loss from clinical leukosis is less important nationally, but in some herds this is a significant problem. An unknown, but potentially important, factor in assessing the impact of BLV is a possible perception by the public that the virus is an undesirable contaminant of milk. Even though current knowledge indicates that BLV does not present a hazard to human health, media reactions and public opinion cannot be predicted with certainty.

Our studies have shown that approximately 1 in 4 animals are BLV seropositive with some herd infection rates as high as 86%. The guidelines that we have proposed rely upon 3 basic control steps. The first is raising uninfected calves to establish a pool of BLV seronegative replacement heifers. The second is preventing blood-borne spread of BLV-infected lymphocytes, and the third is "closing" the herd to BLV seropositive animals.

Raising uninfected calves. Calves are identified as being from BLV seropositive cows or BLV seronegative cows. Those cows from BLV seropositive cows are raised on colostrum and milk from BLV seronegative cows.

Preventing blood-borne spread. Procedures that may lead to inadvertent transfer of blood, hence, BLV, from one animal to another should be modified whenever possible (See Table 2). In addition, an insect control program should be maintained to control BLV spread by blood sucking insects.

Closing the herd. Monitor potential herd replacements for BLV infection prior to purchase. Test herd annually to assure that no new BLV infections are occurring. Those cows that are already BLV seropositive should be culled over time in coordination with the above two steps.
Our investigations into different modes of BLV transmission will continue until we can assure the veterinary profession and the dairy industry that all possible mechanisms of spread have been revealed. At that point in time it will then be the responsibility of the respective groups to formulate ways to implement control measures based on the information presented herein.
Figure 1. Stages of Bovine Leukosis Virus Infection Leading to Clinical Disease
rarely in secretions

- gouge dehorning
- ear tatoos
- cells

in utero secretions

viremia

(cell-free) viremia (cell-associated)

Figure 2. Proposed Mechanisms Whereby Bovine Leukosis Virus is Spread
CONTROL OF BOVINE LEUKOSIS VIRUS INFECTION

Table 1. Prevalence of Antibody to Bovine Leukosis Virus in Holstein Cattle in the Northwestern United States, 1977–86

<table>
<thead>
<tr>
<th>Herd(s)</th>
<th>No. Positive/No. Tested</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-7</td>
<td>120/959</td>
<td>12.5</td>
</tr>
<tr>
<td>8-13</td>
<td>211/559</td>
<td>38.0</td>
</tr>
<tr>
<td>14</td>
<td>4/38</td>
<td>11.0</td>
</tr>
<tr>
<td>15</td>
<td>21/40</td>
<td>53.0</td>
</tr>
<tr>
<td>16</td>
<td>74/364</td>
<td>20.0</td>
</tr>
<tr>
<td>17</td>
<td>52/143</td>
<td>36.0</td>
</tr>
<tr>
<td>18</td>
<td>25/45</td>
<td>55.0</td>
</tr>
<tr>
<td>19</td>
<td>0/24</td>
<td>0.0</td>
</tr>
<tr>
<td>20</td>
<td>26/97</td>
<td>27.0</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>533/2269</td>
<td>23.0</td>
</tr>
</tbody>
</table>

*1977–79 survey
**1980–83 survey

Table 2. Procedures to Consider in the Prevention of Spread of Bovine Leukosis Virus-Infected Blood

<table>
<thead>
<tr>
<th>Critical Procedure</th>
<th>Corrective Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention with instruments</td>
<td>Disinfection: instruments washed and rinsed in warm water, submerged in chlorhexidine\textsuperscript{b} and then in sodium hypochlorite\textsuperscript{c}</td>
</tr>
<tr>
<td>Eartagging and Tattooing</td>
<td>Eartag applicator and tattoo instrument disinfected between calves</td>
</tr>
<tr>
<td>Dehorning</td>
<td>Dehorning instrument disinfected between calves. Bleeding controlled by hemostatis and would sprayed with a disinfectant and an insect repellent</td>
</tr>
<tr>
<td>Teat removing</td>
<td>A separate scalpel blade for every calf; bleeding prevented by hemostasis</td>
</tr>
<tr>
<td>Vaccinations</td>
<td>A new needle for every animal processed: Blood samples, vaccination, TB-testing, etc.</td>
</tr>
<tr>
<td>Rectal palpation\textsuperscript{d}</td>
<td>Separate plastic sleeve for every cow; latex sleeves washed carefully between cows</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Modified from Ruppanner et al, 1983.
\textsuperscript{b}Chlorhexidine = Nolvasan\textsuperscript{\textregistered}
\textsuperscript{c}Sodium hypochlorite = Clorox\textsuperscript{\textregistered}
\textsuperscript{d}This technique is currently being evaluated, 1986–87.
REFERENCES

CONTROL OF BOVINE LEUKOSIS VIRUS INFECTION


REPORT OF THE COMMITTEE ON BLUETONGUE AND BOVINE LEUKOSIS

Chairman: Dr. B. I. Osburn, Davis, CA
Vice Chairman: Dr. L. D. Miller, Ames, IA

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The Bluetongue and Bovine Leukosis Committee met from 1:30–5:30 P.M. on Wednesday, October 22, 1986, in the Shannon Room of the Executive West Hotel in Louisville, Kentucky. There were eighteen committee members and forty-three guests present.

Dr. John Atwell, USDA/APHIS reviewed the import-export regulations, a planned embryo transfer project and commented on state regulations that may influence the movement of ruminants. The factors limiting the distribution of bluetongue are influenced by geography and as a result, this influences the areas from which exports can be made. A caution was offered to states which were considering restricting the movement of livestock based on serology rather than disease. Dr. Atwell indicated that there is no evidence that bluetongue will become established in the northeastern states. Dr. Atwell and Dr. J. Callis, Plum Island, New York, reported on an embryo transfer program that is to be implemented in which 500 embryos collected from foot and mouth disease and bluetongue positive cattle in Brazil will be transferred to U. S. cattle at the Harry S Truman Center. The recipient cattle will be sampled and observed for evidence of disease for sixty to ninety days before they will be moved to ARS facilities. The calves will be monitored for evidence of infection.

Dr. James Pearson, NVSL/APHIS, Ames, Iowa, reported on the activities of NVSL. There were no bluetongue isolations made during the last year and the 2,527 semen samples tested were also negative. Antibody was detected against BTV 10, 11, 13 and 17 in survey samples from the northern states and from export samples from other states. No samples were positive for BTV 2. In October 1985, 8,358 serum samples collected from eighteen northeastern states were tested for antibody by the BTID test and 106 or 1.3% were positive. Five were positive for neutralizing antibody against bluetongue virus. There were 51 BTID test positive
BLUETONGUE AND BOVINE LEUKOSIS

samples that were negative for antibody against BTV type 1 through 20 and EHDV 1 and 2. Twenty-one of the BTID positive samples were EHDV positive. An additional 8,652 samples collected from twelve central and western states were tested and 1,141 or 13.3% were BTID positive. The States of Iowa (4.9%), Montana (4.9%), and Virginia (3.1%) had less than 5%. Western Washington, west of the Cascade range is almost free of bluetongue.

A sentinel herd survey initiated in April 1984 at the Meat Animal Research Center in Clay Center, Nebraska, has yielded 2 BT positive animals in April of 1985. Two BT seropositive animals were detected in the January 1986 sampling. The EHDV neutralizing test yielded 1 of 141 positives in April 1984 and 20 of 133 samples tested in October 1985.

A proficiency test has been successfully completed by 63 participating laboratories.

NVSL is cooperating with the University of California, Davis, and the University of Alabama at Birmingham to evaluate cDNA probes for diagnosis of bluetongue.

Dr. Ed Dubovi of the Diagnostic Laboratory, New York State College of Veterinary Medicine, Ithaca, New York, discussed the bluetongue certification program. Herds are tested between November 1 and April 15 and if all animals are negative, the herd is certified free of bluetongue. A yearly test is required to renew certification. A survey of 6,683 serums yielded 20 positive reactors on the BTID test. Each of these animals could be traced back to states known to have bluetongue. In a companion survey of 6,600 serums collected from animals destined for export, there were 20 positive reactors. Tracebacks on these animals has not been completed. A vector survey program was conducted in 1985 and 1986. Vectors were collected from four counties in southern New York. The culicoides were identified and 6,000 were separated into pools and inoculated into sheep and calves. There have been no seroconversions in sheep indicating that the culicoides did not contain infectious virus. In another study, native species of Culicoides varipennis have been trapped for vector competence studies.

Dr. Lloyd Lauerman of Auburn University, Auburn, Alabama, gave a status report on bluetongue virus serotype 2 in Alabama. He reviewed the isolates of BTV serotypes 2 from sentinel cattle in Florida in 1982, 1983 and 1984. There was no evidence of clinical disease in the cattle from Florida. In 1984, BTV serotype 2 was isolated from cattle in Perry County Alabama which had clinical disease. The signs consisted of erosions of mucous membranes, elevated temperature, and weight loss. In January, 1985 there were twelve abortions in a 100 cow beef herd in Houston County. Bluetongue serotype 2 was isolated from the bone marrow of an 8th month gestation aborted calf. The calf had an undershot jaw. A third isolation of BTV serotype 2 was obtained from a bull calf with clinical disease in Perry County, Alabama in March, 1985. Multiple isolations
were made from this calf. All of the Alabama isolates have electrophoretic profiles similar to those of Ona B as described by Dr. T. L. Barber and E. Collison. Dr. Polly Roy has applied a cDNA probe to tissues from aborted fetuses obtained from four counties in Alabama and she found evidence of bluetongue virus in the tissues. These observations were not confirmed by virus isolation. A serological survey conducted by Dr. Lauerman on 1,400 samples for neutralizing antibodies to BTV serotype 2 indicated that infection had occurred in eighteen counties of which five counties bordered on Georgia, three on Tennessee, and one on Mississippi. Dr. Lauerman indicated that Culicoides insignis the vector from which BTV serotype 2 was isolated in Florida does not occur in Alabama. Studies are underway on the potential vector(s) of BTV-2 in Alabama.

Dr. Don Monke of Select Sires, Plain City, Ohio gave a report on studies carried on bluetongue seropositive bulls in a satellite center at Logan, Utah. Satellite centers such as the one at Logan have been established by Artificial Insemination Centers located in the Northeastern United States so that they are able to distribute semen from BTID positive bulls. The study extending from January 1, 1982 through June 30, 1986 included ten complete herd tests averaging 37 animals per test. In all 71 individual bulls and two steers were studied. Virus was not isolated from any of the bulls during the study nor was there evidence of seroconversion in the seronegative steers or bulls. The work supports that of others in the respect that there is poor correlation between BTID antibodies and viremias and that shedding of virus in semen is not a common event in serologically positive bulls.

A status report on the recently relocated Arthropod Borne Animal Disease Research Laboratory was given by Dr. Albert Luedke of Laramie, Wyoming. The laboratory officially moved from Denver, Colorado to Laramie, Wyoming on October 12, 1985. The Denver facility was closed out in April, 1986. Fifteen individuals from Denver relocated in Laramie. Ten additional individuals have joined the staff at Laramie and five additional positions are to be filled during the next year. Two of the positions to be filled are for an entomologist and for a field virologist. The programs are to be the host animal, the virus and vector.

A study of the economic impact of bluetongue virus on the reproduction of dairy cattle in California was presented by Dr. Bennie Osburn of Davis, California. Dr. Osburn reviewed economic losses attributed to outbreaks of disease in Mississippi, losses of up to $30–40 million in export sales each year, losses estimated by the California sheep industry of $2 million per year, the losses of individual livestock producers who cannot sell seropositive animals as sources of germplasm and the economic losses associated with relocation of AI centers to areas which are free of bluetongue infection. Reproductive losses can be attributed to abortions or malformed calves. These losses are not common in areas endemic for bluetongue unless a new virus is introduced during critical stages of pregnancy. A
study to determine if bluetongue virus infection caused infertility or early embryonic deaths was undertaken on a 1,400 cow dairy in the San Joaquin Valley of California. The dairy was in an area known to be endemic for bluetongue. The study spanned 52 weeks and cattle enrolled in the program were those that were bred by AI on a single day of each week. The cattle were checked for pregnancy 40 to 60 days following breeding. Samples collected at the time of insemination and then at the pregnancy check were heparinized blood and serum. Virus isolations were performed on the blood. The results of the cattle that seroconverted during the interval between insemination and pregnancy indicated that 1) these seroconversions occurred in the fall months; 2) the attack rate was 6 of 105 animals or 8.6%; 3) the services per conception in the seroconverted animals were 3.5 vs. 2.5 in other groups; 4) the number of days open was 152 vs. 112; and 5) the losses attributed to bluetongue on this dairy for the year was $23,000. The results further indicate that there is an association between seroconversions to bluetongue virus and infertility. Based on previous epidemiological work in California, approximately 350,000 dairy cattle would be at risk much like the cows on this dairy. A risk of this nature would translate into a loss of $10 million per year to the dairy industry of California.

Discussion by the committee led to a recommendation that at present the BTID test is a satisfactory test and that the neutralization test be accepted as the most definitive test to be applied to questionable BTID results.

Dr. John Atwell, USDA, APHIS commented that direct economic losses from leukosis are small however, interference and loss of export marketing opportunities are substantial. He stated that Canadian artificial insemination (AI) centers are free of bovine leukosis virus (BLV) and some of the AI centers in the U. S. are also BLV-free. It is clearly evident that BLV transmission via embryo transfer is not a problem if the embryos are properly washed before transfer.

Dr. James Pearson, USDA, APHIS, NVSL, Ames, Iowa, reported that 61 laboratories successfully completed the bovine leukosis proficiency test and are approved to conduct the leukosis agar gel immunodiffusion test for official purposes.

Dr. Mark Thurmond, University of California Veterinary Medical Teaching and Research Center, Tulare, CA reported preliminary results of segregation programs to control bovine leukosis virus (BLV) infection in California dairies. In one dairy, under study for less than one year, segregation and improved management were emphasized. The results showed that BLV transmission in cattle of lactating age was reduced in the herd when seropositive cows were segregated. Transmission of BLV in young cattle was also reduced through segregation, however the practice
of dehorning with gouge or guillotine dehorning instruments was a problem even though the instruments were subjected to cleaning and disinfection between animals. It is likely that the transmission that did occur in this group was related to social contacts made among the blood-contaminated calves after dehorning and not to the dehorning instrument. The results suggest that segregation and management to reduce indirect contact to a minimum may be feasible methods to control BLV infection without culling seropositive cattle. In the other herd, segregation of seropositive lactating cows is not possible. Sale of younger animals is important in this herd and management practices are directed toward preventing infection in the calves. Feeding colostrum from seronegative cows only and individual penning of calves are specific practices. This herd has also been under study for less than one year.

Dr. James Evermann, College of Veterinary Medicine, Washington State University, Pullman, WA commented on laboratory and herd studies in Washington and nearby regions of Oregon and Idaho. The prevalence of BLV infection among dairy cattle in the area is about 25%. Guidelines are being developed for a voluntary control program. Eight herds have been studied for up to 3½ years. Prevalence rates as high as 50% were found on the initial test and the prevalence has been greatly reduced by instituting management practices chiefly intended to eliminate direct or indirect transfer of blood.

Dr. Lyle Miller, College of Veterinary Medicine, Iowa State University, Ames, Iowa, reported on studies to determine the potential for virus transmission from cattle in which inconsistent results have been obtained from repeated serologic tests. Fourteen donor cattle have been tested. All were seronegative at the time they were used as donors and all have proven to be free of infectious BLV. The results indicate that cattle unexpectedly found to be seropositive and subsequently determined to be seronegative, present little if any risk of being a source of infection for other animals.

Dr. Edward Dubovi, New York State College of Veterinary Medicine, Cornell University, Ithaca, New York gave an update on the New York State Bovine Leukosis Program introduced in 1985. The program is voluntary and is part of a State sanctioned effort to control Johne’s disease, bluetongue and bovine leukosis. Currently twenty herds are enrolled in the leukosis control program. Initially the prevalence of BLV infection ranged from 0 to 70% and averaged 32%. During the next year emphasis will be placed on education of other veterinary practitioners and herd owners about aspects of transmission of bovine leukosis and the voluntary control program.

There was a brief discussion of terminology and synonyms for bovine leukosis. The process includes the clinically inapparent phase of virus infection, later development of lymphocytosis affecting about 30% of
BLUETONGUE AND BOVINE LEUKOSIS

infected cattle and neoplasia that occurs in a small percentage (less than 5%) of BLV infected cattle.

The committee recommended four resolutions be passed on to the Resolutions Committee. Three resolutions were for bluetongue and one for bovine leukosis. The meeting adjourned at 5:30 P.M.
BRUCELLA ABORTUS STRAIN 19 VACCINATION OF ADULT BEEF CATTLE AND THE EFFECT OF ANTHELMINTICS

R. P. Crawford, DVM, Ph.D; F. C. Heck, Ph.D; and D. L. Zink, Ph.D

SUMMARY

Annual cumulative incidence of brucellosis reactors in Brucella abortus infected herds ranged from 5% to 26% in 4 anthelmintic treated herds compared to 9% and 29% in 2 untreated herds following whole herd vaccination. The proportions of field strain, strain 19, and no isolation reactors were not affected by anthelmintic treatment at vaccination. The serologic test results following strain 19 vaccination of brucella-free cattle were not affected by treatment with thiabendazole at vaccination. The data support the thesis that simultaneous oral administration of thiabendazole, levamisole or a combination of hexachlorethane and phenothiazine and subcutaneous injection of $3 \times 10^9$ B. abortus strain 19 are compatible herd health management practices in herds with brucellosis.

INTRODUCTION

The administration of an anthelmintic is a common practice in herd health management in many livestock operations. During the development of a herd plan for beef cattle with brucellosis, the possible effect of administration of an anthelmintic at the time of vaccination with Brucella abortus strain 19 is often discussed. In addition to a reduction of cattle handling costs, simultaneous administration of an anthelmintic and strain 19 might improve the immunogenicity of the vaccine. The negative aspect of an immunomodulating agent used with strain 19 vaccine is the positive serologic reactions that might be produced which could result in an inaccurate diagnosis or prolonged quarantine time.

Tetramisole has been reported to significantly increase the protection induced by injection of B. melitensis H38 or B. abortus strain 19 in mice which were subsequently challenged with B. abortus strain 544.\textsuperscript{1,2} Stimulation of cell mediated immunity was not accompanied by antibody increases. Other data suggest that the active ingredient in tetramisole (levamisole) may suppress the humoral responses to viral and bacterial antigens but increase resistance of mice and cattle to pathogenic microorganisms.\textsuperscript{3,4,5}

A review article of immunotherapy reported that levamisole does not alter primary immune responses to vaccination.\textsuperscript{6} Levamisole does not affect B lymphocytes in a direct manner and therefore does not directly

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BRUCELLA ABORTUS STRAIN

affect antibody production. Levamisole caused a significant increase in [3H] thymidine uptake in bovine peripheral blood lymphocytes from both B. abortus infected and vaccinated cattle and also significantly potentiated the B. abortus—induced blastogenesis in lymphocytes from unresponsive cattle. Injection of levamisole 7 days after strain 19 vaccination of steers enhanced mean antibody titers but simultaneous injection of levamisole and strain 19 did not augment the antibody response.

This experiment investigated the effect of three anthelmintics administered to cattle concurrently with strain 19 vaccination. The effect of anthelmintics on brucellosis reactors following whole herd strain 19 vaccination was determined in 6 beef herds infected with B. abortus field strains. The effect of thiabendazole on serologic test results was determined in brucella-free cattle following strain 19 vaccination.

MATERIALS AND METHODS

Cattle: Mixed breed cattle in 6 beef herds which were not calfhood vaccinated with strain 19 were selected. Field strain infection was confirmed by isolation of B. abortus biotype 1. Blood samples were collected on day of vaccination and 2, 6, 12 and 18 months post-vaccination (PV).

A group of 13 non-pregnant 2 year old Hereford females that had not been exposed to Brucella were randomly assigned to the following groups: 6 to thiabendazole treatment and strain 19 vaccination; 6 to strain 19 vaccination only; and 1 to thiabendazole treatment only. Blood samples were collected on day of vaccination and at weekly intervals PV.

Anthelmintic: All anthelmintics were administered orally at the recommended dosage: 66 mg thiabendazole/a/kg body weight; 8 mg levamisole hydrochloride (HCL)b/kg body weight; or a combination of 60 gm of hexachlorethane and 60 gm of phenothiazinec/per animal.

Serology: Serum samples from cattle in the 6 herds with brucellosis were first tested with buffered brucella antigen (card). Samples positive by the card test were further tested by rivanol precipitation plate agglutination test (rivanol) and complement-fixation (CF) test utilizing cold fixation and 2 units of complement. Serum samples from the group of 13 Hereford females were tested by all 3 tests.

Vaccination: Commercially prepared and lyophilized B. abortus strain 19 vaccine was diluted to 3 x 10^9 colony forming units per ml. One ml of vaccine dilution was injected subcutaneously in the neck or shoulder area of female cattle 12 months or older. Male cattle were not vaccinated but did receive anthelmintic.

Bacteriologic Examination: Twenty ml of milk from lactating quar-

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*aOmnizole, Merck & Co., Rahway, N.J.
*bTramisole, American Cyanamid Co., Princeton, N.J.
*cHexaphen, C. J. Martin Co., Nacogdoches, TX.
*dBrucellosis Card Test, Hynson, Westcott, and Dunning, Baltimore, MD.
ters or a composite sample from the udder of non-lactating cows was collected from cattle in the 6 beef herds. Cows selected for bacteriologic testing included cows selected at random and cows with serologic or clinical evidence of brucellosis. Each sample was centrifuged at 6000-7000 g for 15 minutes and 0.01 ml (loopfull) of cream and 0.01 ml of sediment were streaked on single petri plates of nonselective and selective media.\textsuperscript{12} Brucella agar\textsuperscript{e} supplemented with 5\% bovine serum was used as nonselective medium. Farrell's medium was used as selective medium.\textsuperscript{13} The following tissues were collected at slaughter from selected cattle that were milk-culture-negative: suprapharyngeal, prescapular, internal iliac and supramammary lymph nodes; spleen, mammary tissue from each quarter and uterus. Amnionic fluid and fetal tissues were collected from pregnant cattle. Tissues were trimmed of excess fat and both sides of a selected piece (3 x 1.5 cm) rubbed over the surface of plates of nonselective and selective media.

Inoculated plates of media were incubated 7 days at 35 C in 10\% CO\textsubscript{2}. Bacterial colonies resembling \textit{Brucella} were transferred to slants of serum enriched tryptose agar.\textsuperscript{e} Isolates were tested biochemically and serologically according to established procedures.\textsuperscript{14}

\textbf{Reactors:} Card test positive cattle were considered to have been exposed to \textit{B. abortus} field strains prior to vaccination. The population at risk was the number of card test negative cattle in each herd vaccinated with strain 19 and tested PV. Reactors in the year following vaccination were cattle in the population at risk with rivanol 100 and/or Cf 40 titers at 6 months or more PV or \textit{B. abortus} was isolated PV.\textsuperscript{15,16} Field strain reactors were those from which \textit{B. abortus} field strain was isolated. Strain 19 reactors were those from which \textit{B. abortus} strain 19 was isolated.

Cumulative incidence has been defined as the proportion of an initially disease-free group developing disease over a fixed time interval.\textsuperscript{17} Cattle that were card test negative at vaccination were assumed to be disease-free cattle at risk. Brucellosis reactors used to calculate cumulative incidence for the year PV included cattle with a rivanol $\geq$ 100 or CF $\geq$ 40 titers at 6 months or more PV and cattle from which \textit{B. abortus} was isolated PV.

\textbf{RESULTS}

The reactors in female cattle for the year following whole herd strain 19 vaccination are listed in Table 1. The cumulative incidence was 5\% and 14\% for hexachlorehane-phenothiazine (hex-phen) treated herds, 22\% for the levamisole treated herd, and 26\% for the thiabendazole treated herd compared to 9\% and 29\% for the untreated herds.

The proportions of reactors for each herd based on isolation \textit{B. abortus}

\textsuperscript{e}Bacto Brucella agar; tryptose agar, Difco Laboratories, Detroit, MI.
are in Table 2. Field strain reactors ranged from 17% to 67% of the reactors in the anthelmintic treated herds compared to 17% and 100% for the untreated herds. Twelve of the 19 field strain reactors had rivanol 100 and CF 80 titers at 2 months PV. Six field strain reactors had increased serologic reactions after 2 months PV; 1 reactor in each of the 2 hex-phen treated herds, 1 reactor in levamisole treated herd, 1 reactor in untreated herd 79-6, and 2 reactors in thiabendazole treated herd. A field strain isolation was made from a cow in hex-phen treated herd 79-2 that was negative to all 3 serologic tests. Rectal palpation results at vaccination and 6 months PV were both recorded as first trimester pregnancy which suggested a resorbed or aborted fetus following vaccination. *B. abortus* field strain was isolated from lacteal secretions collected 6 months PV. Subsequent lacteal samples and tissues at slaughter were negative for *B. abortus*.

The proportion of strain 19 reactors ranged from zero to 25% of the total reactors in each herd (table 2). Ten strain 19 reactors were detected in the following 3 herds: 3 (25%) strain 19 reactors from untreated herd 79-1; 5 (22%) strain 19 reactors from hex-phen treated herd 79-3; and 2 (8%) strain 19 reactors from levamisole treated herd 79-5.

The proportion of no isolation reactors in each herd with more than 2 reactors ranged from 33% to 67% in anthelmintic treated herds compared to 58% in the untreated herd (table 2).

Seventeen herd bulls in the 6 herds were tested for *Brucella* antibodies. One bull in herd 79-1 was card test positive at PV day 0. The remaining 16 bulls were card test negative and received the following treatment on PV day 0 but were not strain 19 vaccinated: 2 in herd 79-1 and 1 in herd 79-6 received no anthelmintic; 2 in herd 79-2 and 8 in herd 79-3 received hex-phen; 1 in herd 79-4 received thiabendazole; and 2 in herd 79-5 received levamisole. All 16 bulls were card test negative at each herd test PV.

Brucellosis was eliminated from all herds by 1 year PV. None of the herds had new reactor cattle at testing 18 months PV.

The effect of thiabendazole treatment at vaccination on serologic test results for non-pregnant cattle that had not been exposed to *B. abortus* was determined. Card test positive reactions occurred in 4 of 6 thiabendazole treated and all 6 untreated females vaccinated with strain 19. The median rivanol negative and CF 20 titers at 1 week PV were the same for both treated and untreated cattle (table 3). At 4 weeks PV the rivanol titers varied from less than 25 to 100 in both untreated and thiabendazole treated cattle with a median titer of 25. At 4 weeks PV the CF titers varied from less than 10 to 20 in untreated cattle and from less than 10 to 40 in treated cattle. A median CF of 10 for untreated cattle and a CF median of 20 for thiabendazole treated cattle was calculated. At 8 weeks PV, 3 of the 6 cattle in both treated and untreated groups were card positive. Rivanol
and CF tests were negative in untreated cattle at week 8 or longer. An occasional rivanol 25 or CF 10 titer occurred in thiabendazole treated heifers past week 8 PV but all tests were negative at week 11 PV. All tests of the one cow that received thiabendazole and 1 ml diluent without strain 19 were negative.

DISCUSSION

The optimal vaccination program for brucellosis in cattle would cause minimal serologic reactions in diagnostic tests and maximum protection against field strain exposure. In this study the administration of an anthelmintic at vaccination did not increase the serologic responses to B. abortus strain 19. The proportion of no isolation reactors in B. abortus field strain infected herds with more than 2 reactors varied from 33% to 67% in anthelmintic treated herds and was 58% in one untreated herd (table 2). At 1, 4 and 8 weeks PV the serologic test results following strain 19 vaccination of brucella-free cattle were not significantly different in 6 thiabendazole treated cattle compared to 6 untreated cattle (table 3). This data is consistent with the recent report that simultaneous injection of levamisole and strain 19 did not augment the antibody response.9

Twelve (63%) of the 19 field strain reactors had positive serologic test reactions at 2 months PV which suggests these 12 cattle could have been incubating brucellosis at vaccination. Six of the remaining field strain reactors were in 4 treated herds comprised of 356 female cattle (table 1) or 1.7 field strain reactors per 100 treated cattle compared to 1 of 52 or 1.9 field strain reactors per 100 untreated cattle. These data suggest no effect from anthelmintics on strain 19 induced protection against field strain exposure.

The strain 19 isolations were distributed in both treated and untreated herds. The data suggest no effect from anthelmintics on the proportion of reactors from which B. abortus strain 19 was isolated.

Data from this study support the thesis that simultaneous oral administration of thiabendazole, levamisole or a combination of hexachlorethane or phenothiazine and 3x109 B. abortus strain 19 are compatible herd health management practices.
**BRUCELLA ABORTUS STRAIN**

Table 1: Annual Cumulative Incidence of Brucellosis Reactors in Female Cattle Following Strain 19 Vaccination and Anthelmintic Treatment.

<table>
<thead>
<tr>
<th>Herd ID</th>
<th>Cows at Risk</th>
<th>Reactors*</th>
<th>Cumulative Incidence</th>
<th>Anthelmintic at Vaccination</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-1</td>
<td>41</td>
<td>12</td>
<td>29%</td>
<td>None</td>
</tr>
<tr>
<td>79-2</td>
<td>60</td>
<td>3</td>
<td>5%</td>
<td>Hex-phen</td>
</tr>
<tr>
<td>79-3</td>
<td>160</td>
<td>23</td>
<td>14%</td>
<td>Hex-phen</td>
</tr>
<tr>
<td>79-4</td>
<td>27</td>
<td>7</td>
<td>26%</td>
<td>Thiabendazole</td>
</tr>
<tr>
<td>79-5</td>
<td>109</td>
<td>24</td>
<td>22%</td>
<td>Levamisole</td>
</tr>
<tr>
<td>79-6</td>
<td>11</td>
<td>1</td>
<td>9%</td>
<td>None</td>
</tr>
</tbody>
</table>

*Rivanol 100 or CF 40 titer 6 months or more PV or B. abortus isolated.

Table 2: Proportion of *Brucella abortus* Reactors Following Strain 19 Vaccination of Cattle Herds and Anthelmintic Treatment

<table>
<thead>
<tr>
<th>Brucellosis Reactor Designation</th>
<th>Field Strain</th>
<th>Strain 19</th>
<th>No Isolation</th>
<th>Anthelmintic</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>17%*</td>
<td>25%*</td>
<td>58%*</td>
<td>None</td>
</tr>
<tr>
<td>3</td>
<td>67%</td>
<td>0</td>
<td>33%</td>
<td>Hex-phen</td>
</tr>
<tr>
<td>23</td>
<td>17%</td>
<td>22%</td>
<td>61%</td>
<td>Hex-phen</td>
</tr>
<tr>
<td>7</td>
<td>57%</td>
<td>0</td>
<td>43%</td>
<td>Thiabendazole</td>
</tr>
<tr>
<td>24</td>
<td>25%</td>
<td>8%</td>
<td>67%</td>
<td>Levamisole</td>
</tr>
<tr>
<td>1</td>
<td>100%</td>
<td>0</td>
<td>0</td>
<td>None</td>
</tr>
</tbody>
</table>

*Percentage of reactors from which field strain, strain 19 or no B. abortus was isolated.

Table 3: The Effect of Thiabendazole (TBZ) on Serologic Test Titers Following Vaccination with 3x10^9 *B. abortus* Strain 19

<table>
<thead>
<tr>
<th>Weeks PV</th>
<th>Strain 19 Only</th>
<th>Strain 19 plus TBZ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rivanol</td>
<td>CF</td>
</tr>
<tr>
<td>0</td>
<td>Neg.*</td>
<td>Neg.</td>
</tr>
<tr>
<td>1</td>
<td>Neg.</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
<td>10</td>
</tr>
</tbody>
</table>

*Negative at lowest dilution or median titer from 6 adult non-pregnant females.
REFERENCES


DESCRIPTION AND EVALUATION OF AN ENZYME-LINKED IMMUNOSORBENT ASSAY TEST USED FOR BRUCELLOSIS SCREENING OF DAIRY CATTLE IN SOUTHERN CALIFORNIA

Dan E. Suther, D.V.M., M.P.V.M.\textsuperscript{a}
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Lawrence C. Vanderwagen, D.V.M., M.P.V.M.\textsuperscript{c}

SUMMARY

An enzyme-linked immunosorbent assay (ELISA) for brucellosis screening was modified by using standard tube test antigen. This test was compared to the rapid screening test (RST) in two cattle populations: (a) infected herds and (b) market cattle samples. The samples were further tested by the card, rivanol, and complement-fixation tests.

In the infected herd data, 19,835 records were evaluated from nine herds containing 7,889 cattle ($\bar{X} = 876.7$). A total of 122 reactors were found (0.615% of records on 1.55% of cattle). Of the RST negative samples, 641 were ELISA positive of which eight were reactors. Conversely, of the ELISA negative samples, there were 601 RST positive, of which two were reactors. The difference was statistically significant.

There were 3,847 routine MCI samples tested by both RST and ELISA. Supplemental tests revealed 14 reactors. One reactor was detected by ELISA alone; the other 13 were found by both tests.

A one-character computer reporting scheme is reported and several screening levels are discussed.

Under the conditions of this study, the ELISA appeared to be superior to the RST.

INTRODUCTION

After many years of control and eradication effort, bovine brucellosis remains a serious problem in many areas of the United States as well as other countries. These localities must often test thousands of animals from infected herds each week and also operate extensive surveillance programs. Even in areas of low incidence, there is the need to screen massive numbers of serum samples in the market cattle testing program and other surveillance systems.
Current tests used for mass screening include the standard plate test (SPT), buffered acidified plate antigen test (BAPA), the card test (CARD), and the rapid screening test (RST). All of these are agglutination tests. Most of them are nonquantitative, laborious to perform, and not amenable to automation.

The need for a rapid, economical, automated, quantitative, primary antigen-antibody binding test has been well established. Enzyme-linked immunosorbent assay (ELISA) tests have been found useful in a wide variety of applications.

The purpose of this study was to develop and evaluate an ELISA for mass screening in the State-Federal Brucellosis Eradication Program and to compare it to the RST.

**MATERIALS AND METHODS**

**Serological Tests**

An ELISA test was modified by using USDA standard tube antigen rather than a soluble antigen, washing was done with tap water instead of wash solution, and color development was stopped with distilled water instead of hydrofluoric acid. Originally, the positive control sera was from a reactor cow from a local infected herd. This serum was RST and CARD positive and had a complement fixation (CF) titer of 3+ at 1:80. It was shown to be equivalent to USDA #12822 (CF 4+ at 1:80) which is currently being used. The reading for this standard is considered to be 100 per cent absorbence. Duplicate positive and negative controls are used on each plate. The incubated plates were read in an automated reader, and the readings were processed through a computer, and printed. Results were reported as a percentage of the mean absorbence of the positive controls. Because these data were being reported to the USDA, APHIS, Veterinary Services, Brucellosis Information System (BIS) in Ft. Collins, Colorado, it was necessary to convert it to one character in length. An alpha system was devised (Table 1). ELISA values of C and above (≥ 10% absorbence) were considered suspicious (positive at the screening level). Standard serological methods were used for conducting the CARD and rivanol (RIV) tests. The RST used six-minute shaking and standing times rather than four minutes. A microtiter adaptation of the Wisconsin method CF test was performed with the exception that warm fixation was used rather than cold.

The results of these tests were recorded as recommended by the Brucellosis Eradication Uniform Methods and Rules (UMR) and BIS.

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a Received from USDA, APHIS, Diagnostic Reagents, Ames, Iowa.
b Dynatech Microplate Reader, MR600, Alexandria, VA.
c Apple II plus, Cupertino, CA.
d Epson Model MX80, Torrence, CA.
ENZYME-LINKED IMMUNOSORBENT

Infected Herd Data

Data to evaluate the ELISA as a mass screening technique and compare it to the RST were collected from the BIS database. These data had been generated as a part of the ongoing State-Federal Brucellosis Eradication Program in California. Criteria for selection were: (1) The sera had been tested by both RST and ELISA; (2) The samples came from infected herds in Riverside or San Bernardino counties, and; (3) The tests were performed between January 1, 1985, and July 15, 1986. All test records meeting these specifications were transferred via floppy disk to the computer (now Viasyn) at the California Veterinary Laboratory, San Bernardino, California.

Classification of animals into reactor, suspect, or negative status was primarily based on UMR criteria, however, some animals were classified differently, for epidemiological reasons, by the designated epidemiologist in charge of the herd.

Market Cattle Identification Program (MCI) Data

All MCI samples submitted to our laboratory are screened with RST. When laboratory workload allowed, a full day's submission would also be tested with ELISA. Any samples detected by either screening test was tested by CARD, RIV, and CF.

The results of these tests were recorded as recommended by UMR as were the animal classifications.

RESULTS

Infected Herds

Nine herds containing 7,889 cattle were selected. They ranged in size from 389 to 1,745 head per herd with a mean of 876.7. The predominant breed was Holstein-Friesian (approximately 95%), and it was considered a totally calfhood vaccinated population.

There were 19,835 individual test records selected. The individual herds were represented by 610 to 4,560 records per herd, and there was an average of 2.51 records per animal. One-hundred and twenty-two reactors were found in the study. This is 0.615% of the test records and 1.55% of the cattle population.

As expected, a preponderance of samples 18,229 (91.99%) were negative to the RST and in the negative zone (< 10% absorbance) to the ELISA (Table 2). However, within this category there were two reactors based on CARD, RIV, or CF reactions or epidemiologic data.

The smallest category was the samples positive to both the RST and ELISA.

These 364 samples, not surprisingly, yielded the greatest number of reactors (110).
These two groups, which are in agreement, total 18,594 (93.7%).

Of the RST negative samples, 641 (3.23%) were ELISA positive. Supplemental testing of these detected 8 reactors. Conversely, of the ELISA negative samples, there were 601 (3.02%) which were RST positive. Further testing of these samples revealed two reactors.

Comparing the difference between the 8 reactors of 641 ELISA positive/RST negative animals to the two reactors of 601 RST positive/ELISA negative animals was found to be statistically significant. Using the Kappa test, the ELISA and the RST were found to be significantly different also.

The relative sensitivity and relative specificity of the ELISA was 96.7% and 95.5% respectively. Values for the RST were 91.8% and 95.7%.

There were 196 card test positives, which included 103 reactors, but the test did not identify 19 reactors.

Forty-one sera were anti-complementary, and an additional 26 were considered unsuitable for CF testing (6.67%).

MCI

A total of 3,847 routine MCI samples were tested by both RST and ELISA. Supplemental tests revealed 14 reactors (0.36%). One reactor was detected by the ELISA alone, the other 13 were found by both tests (Table 3-A).

As with the infected herd data, most samples, 3640 (94.6%) were negative to both tests. Very few samples, 36 (0.94%), were positive to both tests. There were 132 (3.4%) ELISA positive and RST negative and 39 (1.0%) RST positive and ELISA negative.

Screening at ELISA, ≥D level (Table 3-B, 5) markedly decreased the number of samples required for supplemental testing from 168 to 78 (46.4%). No reactors were undetected with this change.

There were 88 (42.3%) anticomplementary samples of the 208 which were CF tested.

DISCUSSION

Unfortunately in a retrospective field study, when we are unable to determine the actual disease status of all the animals in the study, attempts to calculate true sensitivity and specificity of the tests cannot be done. However, the relative values can be calculated and comparisons between the tests can be drawn. We note that the ELISA has an improved relative sensitivity of 96.7% compared to 91.5% for RST. With a negligible loss of relative specificity from 95.7% for RST to 95.5% for ELISA.

In this study, the ELISA detected six more reactors than the RST by supplemental testing of only 40 more cows. Since the San Bernardino Laboratory annually tests 400,000 samples for brucellosis, which is more
than 20 times the number in this study (19,835), there is the possibility of finding 120 more reactors each year, if the ELISA were used as the official screening test rather than the RST. It might be argued that these 120 reactors would have been found by the RST on future tests, and while that may or may not be true, early detection is certainly preferable.

It is interesting to note the similarity in the percentages of the total reactors which were ELISA positive and RST negative in the infected herd data (6.56%) and the MCI (7.14%).

An additional advantage of the ELISA is that each sample, done in one dilution, provides quantitative results. Therefore, changes in absorbence values, i.e. antibody titer, between tests can be evaluated. With further study, this feature may show the ELISA to have value also as a diagnostic test.

The screening sensitivity of the ELISA can be easily altered merely by selecting a different absorbence % as the suspicious level (Table 4.5) without altering reagents or protocol. In the present study, the suspicious level could be dropped to D (≥ 15% absorbence) without the loss of any reactors and at a savings of 259 samples not being subjected to supplemental tests in the infected herd population. Savings in the MCI population were 90 samples (over 50%). In fact, the sensitivity could be varied depending on disease level in the population and degree of risk one was willing to take.

Primary antigen-antibody binding tests such as the ELISA are not thought to be affected by the prozone phenomenon that occurs with the CF and precipitation and agglutination tests, which further enhances its value.

We have also found the ELISA better able to utilize old, contaminated, and poorly handled sera than could the other tests used in this study. This is especially important in MCI testing where the quality of sera is often quite poor. Note the much higher percentage of anticomplimentary samples in the MCI group (42.7%) than in the infected herd samples (6.67%).

In our laboratory, we are able to complete approximately 200 ELISA tests per technician hour, which compares favorably with the RST rate of 250 per hour and the BAPA at 125 tests per hour.

A recent cost survey in our laboratory found the ELISA to be $0.1289 per test, the RST to be $0.0822 per test, and the BAPA to be $0.1268 per test.

It should be noted that screening tests have varying proportions of false negatives and false positives, depending on administrative decision. In our infected herd data, two reactors were both RST and ELISA negative. Two more were missed by ELISA, and eight more were missed by RST. The card, often considered too sensitive in vaccinated populations, missed 19 cows removed as reactors. While recent reports demonstrate that card negative cows are usually culture negative, a rising titer to a CF or rivanol
test in an individual in an infected herd is still strong evidence for removal.

While a comparison was not done with the BAPA, we believe there are some obvious advantages of the ELISA; (1) There is no prozone effect; (2) it is a quantitative test; and (3) a greater number of tests can be run per technician hour.

We feel this comparison of the ELISA in two populations (infected herds and MCI animals) amply demonstrates it to be equal or superior to the RST as a screening test. There is strong agreement (93.7%) between the two tests, but the ELISA found a statistically significantly higher proportion of reactors.

If the ELISA screening level were set at $\geq D$, fewer samples would require additional testing in the infected herd group, and equal numbers would be needed in the MCI group, than would be selected by the RST (Table 4,5). Our current recommendation is to continue screening infected herd samples at the $\geq C$ level but to lower the level to $\geq D$ for MCI samples.

Table 1. Conversion table of % absorbence of ELISA to alpha character for reporting on BIS*

<table>
<thead>
<tr>
<th>% ABSORBENCE</th>
<th>BIS</th>
<th>% ABSORBENCE</th>
<th>BIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4</td>
<td>A</td>
<td>65–69</td>
<td>N</td>
</tr>
<tr>
<td>5–9</td>
<td>B</td>
<td>70–74</td>
<td>O</td>
</tr>
<tr>
<td>10–14</td>
<td>C</td>
<td>75–79</td>
<td>P</td>
</tr>
<tr>
<td>15–19</td>
<td>D</td>
<td>80–84</td>
<td>Q</td>
</tr>
<tr>
<td>20–24</td>
<td>E</td>
<td>85–89</td>
<td>R</td>
</tr>
<tr>
<td>25–29</td>
<td>F</td>
<td>90–94</td>
<td>S</td>
</tr>
<tr>
<td>30–34</td>
<td>G</td>
<td>95–99</td>
<td>T</td>
</tr>
<tr>
<td>35–39</td>
<td>H</td>
<td>100–104</td>
<td>U</td>
</tr>
<tr>
<td>40–44</td>
<td>I</td>
<td>105–109</td>
<td>V</td>
</tr>
<tr>
<td>45–49</td>
<td>J</td>
<td>110–114</td>
<td>W</td>
</tr>
<tr>
<td>50–54</td>
<td>K</td>
<td>115–119</td>
<td>X</td>
</tr>
<tr>
<td>55–59</td>
<td>L</td>
<td>120 and over</td>
<td>Y</td>
</tr>
<tr>
<td>60–64</td>
<td>M</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*USDA, APHIS, Veterinary Services, Brucellosis Information System, Ft. Collins, Colorado

Table 2. Comparison of results of ELISA tests on cattle from infected herds.

<table>
<thead>
<tr>
<th>ELISA($\geq C$)</th>
<th>NEG.</th>
<th>POS.</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NO. REACTORS</td>
<td>NO. REACTORS</td>
<td>NO. REACTORS</td>
</tr>
<tr>
<td>RST NEGATIVE</td>
<td>18229</td>
<td>2</td>
<td>641</td>
</tr>
<tr>
<td>RST POSITIVE</td>
<td>601</td>
<td>2</td>
<td>364</td>
</tr>
<tr>
<td>TOTALS</td>
<td>18830</td>
<td>4</td>
<td>1005</td>
</tr>
</tbody>
</table>
Table 3-A. Comparison of results of ELISA (≥ C) and RST tests on MCI samples.

<table>
<thead>
<tr>
<th></th>
<th>ELISA (≥ C)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NEG.</td>
<td>POS.</td>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO. REACTORS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RST NEGATIVE</td>
<td>3640</td>
<td>0</td>
<td>132</td>
<td>1</td>
<td>3772</td>
<td>1</td>
</tr>
<tr>
<td>RST POSITIVE</td>
<td>39</td>
<td>0</td>
<td>36</td>
<td>13</td>
<td>75</td>
<td>13</td>
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<tr>
<td>TOTALS</td>
<td>3679</td>
<td>0</td>
<td>168</td>
<td>14</td>
<td>3847</td>
<td>14</td>
</tr>
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</table>

Table 3-B. Comparison of results of ELISA (≥ D) and RST tests on MCI samples.

<table>
<thead>
<tr>
<th></th>
<th>ELISA (≥ D)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NEG.</td>
<td>POS.</td>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO. REACTORS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RST NEGATIVE</td>
<td>3721</td>
<td>0</td>
<td>51</td>
<td>1</td>
<td>3772</td>
<td>1</td>
</tr>
<tr>
<td>RST POSITIVE</td>
<td>48</td>
<td>0</td>
<td>27</td>
<td>13</td>
<td>75</td>
<td>13</td>
</tr>
<tr>
<td>TOTALS</td>
<td>3769</td>
<td>0</td>
<td>78</td>
<td>14</td>
<td>3847</td>
<td>14</td>
</tr>
</tbody>
</table>
SUTHER, COOPER, VANDERWAGEN

Table 4. Distribution of reactors detected in infected herd samples shown by ELISA and RST class.

<table>
<thead>
<tr>
<th>ELISA</th>
<th>NEG.</th>
<th>POS.</th>
<th>CUMULATIVE TESTS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2</td>
<td>2</td>
<td>19835</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>0</td>
<td>2387</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>0</td>
<td>1005</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
<td>1</td>
<td>746</td>
</tr>
<tr>
<td>E</td>
<td>0</td>
<td>1</td>
<td>562</td>
</tr>
<tr>
<td>F</td>
<td>1</td>
<td>1</td>
<td>423</td>
</tr>
<tr>
<td>G</td>
<td>0</td>
<td>0</td>
<td>336</td>
</tr>
<tr>
<td>H</td>
<td>0</td>
<td>2</td>
<td>269</td>
</tr>
<tr>
<td>I</td>
<td>0</td>
<td>1</td>
<td>231</td>
</tr>
<tr>
<td>J</td>
<td>0</td>
<td>0</td>
<td>207</td>
</tr>
<tr>
<td>K</td>
<td>0</td>
<td>3</td>
<td>190</td>
</tr>
<tr>
<td>L</td>
<td>0</td>
<td>1</td>
<td>175</td>
</tr>
<tr>
<td>M</td>
<td>0</td>
<td>2</td>
<td>162</td>
</tr>
<tr>
<td>N</td>
<td>1</td>
<td>1</td>
<td>154</td>
</tr>
<tr>
<td>O</td>
<td>0</td>
<td>2</td>
<td>146</td>
</tr>
<tr>
<td>P</td>
<td>0</td>
<td>5</td>
<td>136</td>
</tr>
<tr>
<td>Q</td>
<td>0</td>
<td>4</td>
<td>116</td>
</tr>
<tr>
<td>R</td>
<td>0</td>
<td>17</td>
<td>108</td>
</tr>
<tr>
<td>S</td>
<td>0</td>
<td>13</td>
<td>87</td>
</tr>
<tr>
<td>T</td>
<td>2</td>
<td>18</td>
<td>71</td>
</tr>
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<td>U</td>
<td>2</td>
<td>18</td>
<td>45</td>
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<td>V</td>
<td>0</td>
<td>8</td>
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</tr>
<tr>
<td>W</td>
<td>1</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>X</td>
<td>1</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Y</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

**REACTORS** 10 112 = 122

*The number of samples selected for supplemental testing at each screening level.
Table 5. Distribution of reactors detected in MCI samples shown by ELISA and RST class.

<table>
<thead>
<tr>
<th>ELISA</th>
<th>NEG.</th>
<th>POS.</th>
<th>CUMULATIVE TESTS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>A &amp; B</td>
<td>0</td>
<td>0</td>
<td>3847</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>0</td>
<td>168</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
<td>0</td>
<td>78</td>
</tr>
<tr>
<td>E</td>
<td>0</td>
<td>0</td>
<td>52</td>
</tr>
<tr>
<td>F</td>
<td>0</td>
<td>0</td>
<td>31</td>
</tr>
<tr>
<td>G</td>
<td>0</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>H</td>
<td>0</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>I</td>
<td>0</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>J</td>
<td>0</td>
<td>0</td>
<td>17</td>
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<td>K</td>
<td>0</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>L</td>
<td>0</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>M</td>
<td>0</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>N</td>
<td>0</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>O</td>
<td>0</td>
<td>2</td>
<td>16</td>
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<tr>
<td>P</td>
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<td>1</td>
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</tr>
<tr>
<td>Q</td>
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<td>1</td>
<td>11</td>
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<td>R</td>
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<td>3</td>
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</tr>
<tr>
<td>T</td>
<td>0</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>U</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

REACTORS 1 13 = 14

*The number of samples selected for supplemental testing at each screening level.

REFERENCES


STATUS REPORT — 1986
COOPERATIVE STATE-FEDERAL BRUCELLOSIS ERADICATION PROGRAM
Jan D. Huber, D.V.M., M.S.
Mitchell A. Essey, D.V.M.
Hyattsville, MD

Fiscal year (FY) 1986 became the 5th consecutive year in which there were fewer reactor herds and the 8th straight year with a reduction in the number of reactor cattle.

This encouraging progress indicates that a concerted Federal, State, and industry effort during the next 4 fiscal years will result in a smooth and natural transition to a different but more efficient division of roles. Veterinary Services is in the process of defining in detail how Federal resources will be utilized until FY 1991 and beyond. Those States with little or no brucellosis at the end of the next 4 years will find it easier to be ready for added responsibilities.

The information on the following visuals is estimated since data for the final month of the fiscal year was not available at the time the visuals were prepared.

Slide 1
On September 30, 1986, 23 States, plus Puerto Rico and the Virgin Islands, held Class Free status; 17 States were Class A; 5 States were Class B; and 2 States Class C. In addition, Arizona has both a Class Free and Class A area, and Florida and Texas have both Class B and Class C areas. New Jersey, West Virginia, and Puerto Rico qualified for Class Free status during the fiscal year; and Nevada advanced from Class B to Class A. The area in Arizona, north of the Grand Canyon, became Class Free.

Slide 2
There were 5,256 reactor herds found in FY 1986, 25 percent less than the 6,985 detected the previous fiscal year. Class C areas account for 3,183 reactor herds; Class B areas, 1,647; Class A areas, 409; and the Class Free States, 17. Of the 17 reactor herds in Class Free States, 11 were proven to be infected with Strain 19.

Slide 3
The distribution of reactor herds remains similar to previous fiscal years, with 84.6 percent of the Nation's total occurring in 7 States and 15.4 percent in the rest of the country. There are 37 States, each with less than 30 reactor herds, accounting for 2.9 percent of the total. Six States, having between 30 and 300 each, make up 12.5 percent and 6 States, with 300 to 1,000 reactor herds, represent 53.5 percent of the total. Texas had 31.1 percent of the 5,256 reactor herds found during the fiscal year. The 37
NELSON, HUBER, ESSEY

States with a total of 154 reactor herds have 47 percent of the U.S. total of beef cows that have calved and 81 percent of the milk cows that have calved, or 51 percent of all cows.

Slide 4
Infection was disclosed in 105 dairy herds as a result of testing brucellosis-ring-test-suspicious herds. There were 2,239 suspicious ring tests, of which 1,530 were blood tested.

Slide 5
Thirteen million cattle were tested under the Market Cattle Identification (MCI) program in FY 1986, a decrease of 700,000 from the 13.7 million tested in FY 1985. Of this year’s total, 45.9 percent were tested at packing plants and 54.1 percent at livestock markets, farms, and ranches. Although the total has decreased, there was a slight increase in cattle tested at slaughter.

Slide 6
The total number of cattle tested in FY 1986 was 17.7 million, with 4.7 million of these tested on the farm or ranch and 13.0 million tested under the MCI program. The number of reactors found declined from 103,000 in FY 1985 to 78,000 in FY 1986. Although there was a 9 percent decline in the total cattle tested in FY 1986, there was a 24 percent decline in the number of reactors found.

Slide 7
The number of calves vaccinated in FY 1986 was 8.8 million, a decrease of 500,000 from FY 1985. This may be a reflection of the national reduction in the calf crop and heifers kept for replacement.

Slide 8
The number of swine tested for brucellosis in FY 1986 was 3.2 million, an increase of almost 11 percent over the number tested in FY 1985. This total included 2.7 million tested under the Market Swine Testing (MST) program (up 13 percent) and 488,500 tested on farms (up 9 percent). The increase in samples collected at slaughter occurred despite a 26 percent reduction in the numbers of mature swine slaughtered. As the result, the percentage of mature swine bled at slaughter increased from 38.5 percent in FY 1985 to 65 percent in FY 1986.

Slide 9
The reactor rate for all tests decreased from 0.043 percent in FY 1985 to 0.03 percent in FY 1986, a drop of 30 percent. The most marked reduction was found in on-farm testing which dropped from 0.12 percent reactors in FY 1985 to only 0.05 percent in FY 1986, a drop of 58 percent. This significant drop was the result of the detection of only 21 infected swine herds during FY 1986, of which almost all were promptly depopulated.
Slide 10

Three States (Nebraska, Ohio, and Virginia) attained Validated Brucellosis-Free Area status — Stage III — during the year, bringing to 30 the number of States that have achieved this goal. The majority of the Nation's swine are now located in States that are Validated Brucellosis-Free.

In addition to Nebraska, Ohio, and Virginia, the States of Alaska, Arizona, California, Colorado, Delaware, Idaho, Indiana, Iowa, Maine, Maryland, Minnesota, Montana, Nevada, New Hampshire, New York, North Dakota, Illinois, Pennsylvania, Rhode Island, South Dakota, Utah, Vermont, Washington, Wisconsin, and Wyoming, as well as Puerto Rico and the Virgin Islands, held Validated Brucellosis-Free status at the end of FY 1986.

Seven States (Alabama, Arkansas, Connecticut, Georgia, Hawaii, Louisiana and Oklahoma) were in Stage II. Eight States (Florida, Kansas, Kentucky, Massachusetts, Michigan, New Jersey, North Carolina and South Carolina) were in Stage I. Seven States (Mississippi, Missouri, New Mexico, Oregon, Tennessee, Texas, and West Virginia) remained in the "no program" classification at the end of FY 1986.

Slide 11

The number of Validated Brucellosis-Free herds decreased from 4,184 in FY 1985 to 2,936 at the end of FY 1986, a drop of 30 percent. This resulted from major program changes in two States — Connecticut and Massachusetts — which no longer test all breeding swine herds annually. Historically, these States together had accounted for about one-fourth of the Nation's Validated herds.

All indications are that the prevalence of swine brucellosis in the United States remains extremely low — well within the level that would justify program acceleration for final eradication. The main obstacle to early eradication of this disease continues to be the lack of adequate identification for tracing MST reactors. Existing swine identification regulations are no longer adequate for meeting the needs of modern swine slaughtering procedures.
Cattle Brucellosis

State Classifications

<table>
<thead>
<tr>
<th>Number</th>
<th>Free</th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herd Infection Rate</td>
<td>23</td>
<td>17</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Adjusted MCI Rate</td>
<td>≤0.05%</td>
<td>&lt;0.1%</td>
<td>&lt;0.3%</td>
<td>&gt;0.3%</td>
</tr>
</tbody>
</table>

*Not included:
States with dual status:
Arizona—Free and A
Florida and Texas—B and C
District of Columbia—Free
Virgin Islands—Free
Puerto Rico—Free
Yellowstone National Park, WY—Not Classified

September 1986
Brucellosis Eradication

Number of Reactor Herds Found
(According to State Classification)

State Classification  New State Classification (Effective May 1, 1982)

<table>
<thead>
<tr>
<th>Class Free</th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
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<tbody>
<tr>
<td>Certified-Free</td>
<td>Modified Certified</td>
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<td></td>
</tr>
</tbody>
</table>

Thousands

Fiscal Year

1979 12,320
1980 12,754
1981 11,324
1982 364
1983 441
1984 474
1985 381
1986 9

Classifications (before May 1982)

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Certified Free</th>
<th>Modified Certified</th>
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<td>20</td>
</tr>
<tr>
<td>1980</td>
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<td>19</td>
</tr>
<tr>
<td>1981</td>
<td>32</td>
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<tr>
<td>1982</td>
<td>32</td>
<td>18</td>
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</tbody>
</table>

New Classification

<table>
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<tr>
<th>Class Free</th>
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<th>Class B</th>
<th>Class C</th>
</tr>
</thead>
<tbody>
<tr>
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<td>16</td>
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<td>1984+</td>
<td>20</td>
<td>19</td>
<td>10</td>
</tr>
<tr>
<td>1985 &amp; 1986</td>
<td>24</td>
<td>19</td>
<td>8</td>
</tr>
</tbody>
</table>

States with dual status:

- Wyoming—Class Free and Class A
- Texas and Florida—Class B and Class C
- Montana—Class Free and Class A
- Arizona—Class Free and Class A
- Texas and Florida—Class B and Class C

*Estimated
Brucellosis Eradication

Percent of Total Reactor Herds Found

*Fiscal Year 1986
Total Herds: 5,256

31.1%
States: 1
Herds: > 1,000
Total Reactor Herds = 1,636

2.9%
States: 37
Herds: < 30
Total Reactor Herds = 154

12.5%
States: 6
Herds: 30 < 300
Total Reactor Herds = 655

53.5%
States: 6
Herds: 300 < 1,000
Total Reactor Herds = 2,811

*Estimated
Brucellosis Eradication

Milk Ring Test Results (BRT)

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<tbody>
<tr>
<td>Suspicious BRT Tests</td>
<td>2,018</td>
<td>2,586</td>
<td>2,177</td>
<td>3,091</td>
<td>4,771</td>
<td>3,607</td>
<td>3,519</td>
<td>2,412</td>
<td>1,775</td>
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<tr>
<td>Follow-up Herd Blood Tests</td>
<td>1,629</td>
<td>2,276</td>
<td>1,914</td>
<td>2,336</td>
<td>3,193</td>
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<td>2,224</td>
<td>1,776</td>
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<tr>
<td>Infected Herds Found</td>
<td>601</td>
<td>335</td>
<td>350</td>
<td>317</td>
<td>260</td>
<td>287</td>
<td>287</td>
<td>165</td>
<td>150</td>
<td>165</td>
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*Estimated
## Brucellosis Eradication
### Market Cattle Testing Program

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>At Packing Plants</th>
<th>Other</th>
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<tbody>
<tr>
<td>1976</td>
<td>69.6%</td>
<td>30.4%</td>
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<tr>
<td>1977</td>
<td>67.5%</td>
<td>32.5%</td>
</tr>
<tr>
<td>1978</td>
<td>62.2%</td>
<td>37.8%</td>
</tr>
<tr>
<td>1979</td>
<td>54.8%</td>
<td>45.2%</td>
</tr>
<tr>
<td>1980</td>
<td>41.7%</td>
<td>58.3%</td>
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<tr>
<td>1981</td>
<td>42.0%</td>
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<tr>
<td>1982</td>
<td>44.4%</td>
<td>55.6%</td>
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<tr>
<td>1983</td>
<td>43.3%</td>
<td>56.7%</td>
</tr>
<tr>
<td>1984</td>
<td>45.6%</td>
<td>54.4%</td>
</tr>
<tr>
<td>1985</td>
<td>42.3%</td>
<td>57.7%</td>
</tr>
<tr>
<td>*1986</td>
<td>45.9%</td>
<td>54.1%</td>
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*Estimated
Brucellosis Eradication

Blood Testing: Cattle

Fiscal Year

Millions Cattle Tested

Thous. Reactors Found

*Estimated
Swine Brucellosis

Animals Blood Tested

Thous. Animals

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Total Tests</th>
<th>On Farm</th>
<th>MST</th>
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<tbody>
<tr>
<td>1977</td>
<td>1500</td>
<td>1000</td>
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<tr>
<td>1986</td>
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</table>

*Estimated
Swine Brucellosis

Infection Rate

Percent

0.5

0.4

0.3

0.2

0.1

0


Fiscal Year

Total Tests   On Farm   MST

*Estimated
Swine Brucellosis

Validated Herds FY 1986

Total Herds: 2936*

*Estimated
REPORT OF THE COMMITTEE ON BRUCELLOSIS

Chairman: Mr. J. B. Armstrong, Kingsville, TX

Vice Chairman: Dr. J. A. Cobb, Atlanta, GA

Dr. J. A. Acree, CA; Dr. L. G. Adams, TX; Mr. J. Adams, VA; Dr. W. F. Alexander, WI; Dr. J. L. Alley, AL; Dr. J. N. Armstrong, NV; Dr. J. M. Arnoldi, WI; Dr. J. F. Badger, MO; Dr. C. E. Barton, TN; Dr. H. J. Bearden, MS; Mr. A. Bellotto, FL; Mr. N. Black, MN; Dr. R. G. Burdett, OR; Mr. J. S. Cargile, TX; Mr. D. B. Childs, FL; Mr. R. Combs, NV; Mr. T. Cook, DC; Dr. A. M. Creswell, TN; Dr. B. L. Deyoe, IA; Dr. M. L. Dierks, NE; Dr. P. B. Doby, IL; Dr. F. J. Drazek, NY; Mr. H. F. Embry, IL; Dr. S. R. England, NM; Dr. B. H. Esrey, OK; Dr. M. A. Essey, MD; Dr. W. B. Fairchild, LA; Dr. L. C. Faulkner, OK; Dr. D. E. Flagg, ND; Dr. G. H. Frye, MD; Mr. B. Gallagher, SD; Mr. P. D. Gentry, NM; Mr. F. D. Gregerson, CO; Mr. J. H. Hagler, TX; Mr. G. A. Hall, OK; Dr. R. E. Hall, WI; Mr. W. T. Harrer, MT; Dr. R. L. Hartin, OK; Ms. J. B. Hebbring, SD; Dr. J. B. Hendricks, SC; Dr. L. W. Hinchman, IN; Dr. E. R. Hinshaw, AZ; Dr. J. W. Holcombe, TX; Mr. J. E. Horne, OK; Mr. R. Schnell, ND; Dr. C. N. Jewett, AR; Mr. A. W. Keating, IL; Dr. W. D. Knox, WI; Dr. J. D. Kopec, MD; Dr. M. H. Lang, IA; Mr. L. D. Mark, VA; Dr. H. F. McCrory, MS; Dr. D. Meeker, IA; Dr. H. F. Moberly, Jr., IL; Dr. F. J. Mulhern, DC; Dr. W. G. Nelson, ID; Mr. R. E. Nelson, VT; Dr. J. L. O'Harra, AZ; Mr. J. O. Pearce, Jr., FL; Dr. P. A. Pickerill, MS; Dr. D. F. Pietz, IA; Dr. W. D. Prichard, OR; Dr. V. B. Ricketts, MO; Mr. D. M. Rogers, NM; Dr. A. J. Roth, VA; Mr. L. D. Schaffer, NE; Mr. G. Scholmer, WA; Dr. L. M. Schmall, IA; Dr. R. Schultz, IA; Dr. G. Schurig, VA; Dr. J. E. Slauter, MO; Mr. W. E. Stemler, IL; Dr. B. W. Stemshorn, Canada; Dr. N. R. Swanson, WY; Dr. E. T. Thorne, WY; Dr. D. K. Thorpe, SD; Dr. W. C. Tobin, CO; Dr. L. C. Vanderwagen, CA; Dr. D. U. Walker, VT; Dr. A. J. Winter, NY; Dr. T. H. Woods, AR; Dr. E. W. Zirkle, NJ; Dr. R. S. Wilson, TX; Dr. L. P. Thomas, WV.

As is normally the case, the Brucellosis Committee had a lively and productive session in which many issues were discussed and resolved. It was pointed out that we have come a long way towards brucellosis eradication, but that we have still got a long and difficult job ahead of us, especially in the light of our present perspective on budgetary constraints.

With regards to bovine brucellosis, there are presently 23 Class Free States, 1 Class Free-A, 17 Class A, 5 Class B, 2 Class B-C states, and 2 Class C states. In federal fiscal year 1985, we had 6,985 infected herds disclosed; whereas, we found 5,256 infected herds in FY 1986. With swine brucellosis, we have displayed similar progress, with only 21 infected herds being disclosed in all of last year; whereas, 53 were found the previous year.

The Committee discussed many issues, and voted on numerous proposed
REPORT OF THE COMMITTEE

resolutions. Chairman John Armstrong reminded the assembly that whatever changes that they proposed in the U.M. and R. had to fulfill two criteria:

1. They had to promote the confidence and cooperation of the industry; because, without the support of the industry, any eradication program would be doomed to defeat.

2. They had to be scientifically valid and justified, if we could expect them to contribute effectively to the brucellosis eradication effort.

So, with that in mind, the many resolutions were heard, discussed, and (in some cases) cussed, until they were brought to the floor for a vote.

Actions Taken

Mr. Bill Gallagher proposed a resolution mandating a standardized flat rate indemnity for reactors ($150 per head, regardless of breed or registration status), and for incentive depopulation of negative exposed animals ($500 per head) in Class Free and A States. After much discussion, amendments, and counter amendments, the resolution was tabled for consideration at next year's meeting.

Dr. J. E. Slauter resolved a sliding-scale indemnity payment schedule for depopulation (the rates depending on the state classification) be adopted:

Class Free: Appraisal value minus salvage value up to $1,000 per head.
Class A: $150 per head.
Class B: $75 per head.
Class C: $50 per head.

Again, this resolution was the object of much discussion; but, ultimately, it was tabled for future consideration.

Dr. Robert Hartin proposed a resolution to re-establish the federally funded fee basis calfhood vaccination program in high incident states. Dr. J. Lee Alley amended Dr. Hartin's motion by specifying that those federal funds not be used to reimburse veterinarians for vaccinating calves at auction markets or concentration points just to qualify them for interstate movement. Both the amendment and the main motion carried by voice vote.

A resolution submitted by Dr. Jim Badger to adopt the Particle Concentration Fluorescence Immunoassay (PCFIA) test as an official testing method in the U.M. & R. was discussed. It was decided that (according to present U.M. and R. criteria) that it could be used as a supplemental or experimental test, but that it was not ready yet to be used as a diagnostic (i.e., to classify reactors) test.

Dr. Garry Adams, of the Scientific Advisory Committee, presented his views on the recommendation that had been made by Mr. Joe Huff (Color-
BRUCELLOSIS

Dr. Miles Berry (NVSL) that a 10% allowance be granted for the manufacturer's documentation of cell viability of the reduced dosage Brucella abortus St. 19 vaccine. The committee recommended that a 10% allowance be granted for the lower limit (i.e., allow a viability down to $2.7 \times 10^9$ cells/dose), but that the upper limit ($1.0 \times 10^{10}$ cells/dose) remain intact. That recommendation was approved unanimously.

Dr. N. R. Swanson recommended the abolishment of the testing requirements on commuting rodeo bulls. The Scientific Advisory Committee (Dr. Garry Adams) said that they would accept that recommendation provided that it was restricted to bulls only, that each bull was individually identified, that the movement involved no change of ownership, that proper health certificates accompanied the animal, that state officials were made aware of all movements, and that the bull was participating in a recognized and organized performance group. Dr. Taylor Woods proposed an amendment to that recommendation which stipulated that the bulls be tested at least once a year. The Scientific Advisory Committee's recommendation was then unanimously approved as it was amended.

Mr. George Hall proposed that the testing requirements on slaughter bulls moving through the first point of concentration (markets) not be mandatory. There was no discussion on the matter and it was soundly defeated.

Dr. J. Lee Alley made a motion that brucellosis restricted (B and S brands) cattle be allowed to move from a livestock market through one approved concentration yard for shipment to slaughter or to a quarantined feedlot. He specified that this approved concentration yard may be an existing facility with approval to handle all classes of cattle and that the restricted cattle would be confined to the designated restricted pens in the yard. This resolution was approved by the group in attendance.

Dr. Jack Armstrong, representing the Western States Livestock Health Association, submitted a resolution to make the U. M. and Rs restrictions on heifer calves moving out of quarantine herds in all states the same, effective January 1, 1987. Dr. Garry Adams, of the Scientific Advisory Committee, stated that handling heifer calves the same in quarantined herds in all states was epidemiologically sound. But, in the discussion that followed, it was pointed out that changing the already mandated time table in the U.M. and R. would severely damage the credibility of the USAHA's Brucellosis Committee and the Brucellosis Eradication Program. Dr. Armstrong's motion failed to gain approval.

Mr. J. O. Pearce, representing the Heifer Syndrome Subcommittee, also submitted a recommendation urging the USDA to adopt rules that would treat heifers, in all quarantined herds in all states, the same. (In other words, prior to the movement of those heifers out of the herd, they must be S-branded or spayed; or if they are retained in the herd, they must be
tested negative at least 30 days after they have calved). Mr. John Adams stated that the intent of the recommendation was to achieve uniformity in all of the receiving states. The recommendation was defeated by a roll call vote.

In addition to the recommendations and resolutions that were acted on by the group, several reports on other activities were presented.

Dr. Richard Crawford, of Texas A and M University, reported on the research findings concerning the effects of the simultaneous administration of anthelmintics and *Brucella abortus* St. 19 vaccine in adult animals. He surmised that worming and vaccination at the same time was a sound herd health management practice, without promoting persistent antibody titers.

Dr. Robert Brown gave a brief summary of the Auburn University study on the progeny of brucellosis infected cows. Among the viable calves (164 heifers and 69 bulls) harvested from 648 reactor dams in the study, latency of infection could not be demonstrated.

Dr. Brian Espe gave a report on an earlier meeting of the Education Subcommittee. It was recommended that the individual states provide, with regularity, a list of quarantined herd owners to groups involved in the enterprise of education (such as the Kerr Foundation and LCI) to facilitate the distribution of educational material to them. It was also recommended that the livestock auction markets be cultivated as another vehicle for the distribution of information about the dreaded disease of brucellosis.

Dr. F. J. Drazek elaborated on some of the problems that have been encountered in the brucellosis eradication program in New York. He emphasized that those same problems had to be confronted and defeated in the higher incidence states today, if we are to achieve success in the eradication of the disease.

Dr. Espe and Dr. Dave Reed gave an update on the progress in the development of new immunogens and diagnostic tests through the use of genetic engineering technology. They urged that funding continue to be provided for such a promising field.

Mr. John Armstrong, Chairman of the Brucellosis Committee, expressed optimism and (in fact) excitement about the future of the Brucellosis Eradication Program. He said that he was “exuberant” about the recent advancements in diagnostic tests, about some of the new research findings, and about the statistics which demonstrate real progress in the program.
BRUCELLOSIS

REPORT OF THE SWINE BRUCELLOSIS SUBCOMMITTEE

The subcommittee meeting was called to order at 1:30 p.m., October 20, 1986, by Chairman, Dr. Paul B. Doby, with the following members present or officially represented by a substitute: Dr. W. R. Alexander, OK; Mr. N. Black, MN; Dr. J. A. Cobb, GA; Mr. R. Combs, NV; Dr. A. M. Creswell, TN; Dr. M. A. Essey, MD; Dr. M. H. Lang, IA; Dr. F. G. Mulhern, DC; Dr. H. F. Moberly, Jr., IL; Dr. P. A. Pickerill, MS; Dr. R. Schultz, IA.

Dr. Mitchell Essey of APHIS reported that the prevalence of swine brucellosis is at an "extremely low level" which seems to justify consideration of a major push to wipe it out.

He reported that the number of animals tested for the disease during the last federal fiscal year showed an 18% increase over the previous year to more than 3.1 million sows and boars. About two-thirds of those animals were identified, but he pointed out this represents selective sampling since those animals most likely to be identified are selected for sampling. Of those tested, 2.7 million were sampled at slaughter, 65% of total slaughter of sows and boars. A total of 745 of the samples were positive on the card test and 222 of those were rivanol positive, a rivanol positive rate of 0.008% in the MST program.

The number of validated herds showed a substantial drop during the last year, to 2,936 validated free herds in the country. There have been about 4,000 validated herds in the country in previous years. Essey explained that some of the decrease resulted from changes in the testing programs in Connecticut and Massachusetts.

During the past year, three states — Nebraska, Ohio and Virginia have qualified for free status and since the end of the fiscal year, another state, Connecticut, has qualified free, bringing the total to 31 validated free states. There are 7 states with no program, 8 in stage 1, and 6 in stage 2. The free state total includes Puerto Rico and the Virgin Islands.

There are 21 newly infected herds disclosed during the past year in 8 states. Those infected herds were in South Carolina, 7; Georgia, 5; Massachusetts, 3; New Jersey, 2; and one herd in Connecticut, Alabama, Florida and Missouri. Later discussions with the State Veterinarian in Missouri revealed that he was unaware of the positive herd recorded for that state, indicating a need for better communications and recordkeeping in regard to infected herds.

The 21 new herds disclosed during the year represented a decline from 192 in 1980 and compared with 53 last year.

Essey said the traceback efficiency of all positives in '86 was 61% last year (61% of the positives were successfully traced to farm of origin), compared with 57% the previous year. With respect to rivanol positives only, traceback efficiency last year was 73%, compared with 63% the previous year. Five of the no-program states, with 25 rivanol positives,
REPORT OF THE COMMITTEE

reported no tracebacks last year, while two of the states listed as having no program, Missouri and Oregon, traced positives as though a program was in effect.

Essey then discussed the proposed 5-year Swine Brucellosis Eradication program. (Amended copy attached.)

He reported that the first required change listed for successful implementation of the program, "Regulations to require backtags or eartags for identification of adult sows and boars moving to slaughter," an amendment to the CFR recommended by the committee for the past several years, is now in the final stages for final publication which is expected soon.

On motion by Black, seconded by Lang, the committee approved a change in Point 3 of the Required Changes section of the proposal to make that section read: "3. Intensify slaughter surveillance in states with a known prevalence of the disease or in those with unknown status by concentrating on blood and identification collections in major slaughtering establishments where breeding swine from those areas are slaughtered."

On motion by Meeker, seconded by Black, the committee approved a recommendation that APHIS investigate the possibility of surveillance slaughter testing on a multi-disease basis (possibly including pseudorabies and trichinosis as well as brucellosis.)

On motion by Mulhern seconded by Alexander, the committee approved a recommendation that the brucellosis scientific advisory committee be asked to analyze the threat to the domestic swine population represented by the prevalence of swine brucellosis in feral swine.

The committee approved on motion by Black, seconded by Meeker, the addition of the following to the required changes section of the 5-year proposal: "11. That states be encouraged to relax change of ownership testing requirements on breeding stock moving from or within free states."

On motion by Black, seconded by Mulhern, the proposed 5-year plan was approved as amended.

The committee was pleased to hear a report by Dr. Ed Slauter of Missouri to the effect that a swine advisory committee has been formed in that state and plans are underway to submit an application to APHIS for recognition of the State as being in stage 1 of the program, reducing the number of "no-program" states in the county to six.

Dr. Alfred Creswell of Tennessee reported that testing of feral swine entering the state has resulted in positive hogs in two cases, one of which was sent to slaughter. In the second group, however, an appeal of a court ruling in favor of the department was overturned on grounds that feral swine are under the jurisdiction of the wildlife agency and not the department of agriculture.

The committee approved on motion by Creswell, seconded by Ronnie
BRUCELLOSIS

Pollen (substituting for Bob Combs on the committee) that APHIS develop a federal regulation to restrict interstate movement of feral swine, perhaps by amending definitions in the present regulations.

Dr. Jim Quigley of Georgia (substituting for Dr. John Cobb on the committee) reported that the Georgia program has been successful in reducing the number of quarantined herds in the state, primarily by depopulating known infected herds. Of 16 herds under quarantine, 7 have been depopulated, two more have been released from quarantine since October 1 after depopulation and several others have negative tests and await additional negative test results for release of quarantine. One herd composed of feral swine remains under quarantine awaiting solution for eliminating the infection. One solution may be to open the herd for hunting, thereby reducing the number of infected animals. The successful depopulation program being used in Georgia is based on a signed agreement with the herd owner that results in payment of indemnity $60.00 per breeding animal, over slaughter recovery, if the herd is depopulated within 30 days, reducing to no indemnity if depopulation is delayed for 90 days or more.

Dr. W. F. Alexander of Oklahoma reported regulations have been implemented in that State for a swine brucellosis program and an advisory committee has been organized, resulting in the State moving to stage 2 of the program. Required change of ownership testing and validated herd testing has resulted in testing of 11,000 to 12,000 samples per month. Some 30 to 40 feral swine from the southwest corner of the State have also been sampled. No positives have been disclosed.

Essey reported on the New Jersey situation in the absence of Dr. Price. He said a program in two garbage fed infected herds to send breeding animals to slaughter and castrate all boars to make sure that no females are bred, with continuation of feeding, has resulted in successful elimination of the disease.

The meeting was adjourned at 4:00 p.m.

5-YEAR SWINE BRUCELLOSIS ERADICATION PROGRAM (Proposed)

Twenty-eight States plus Puerto Rico and the Virgin Islands currently hold Validated Brucellosis-Free status in the Swine Brucellosis Eradication Program, and several other States are approaching that status. In Fiscal Year (FY) 1986, a total of 21 infected herds were reported from 8 States, further indication that the level of infection in the United States is very low.

The current program, although it has effectively reduced infection to its present level, has certain deficiencies which are hampering the final drive
REPORT OF THE COMMITTEE

toward eradication. This proposal would correct these deficiencies with the intent of completing the eradication effort in 5 years and thereby eliminate further losses from the disease and costs of the program.

The proposed 5-year plan would —

1. Be developed with input from representatives of the swine industry and from State officials.

2. Maintain the basic structure of the current Swine Brucellosis Eradication Program.

3. Improve surveillance under the Market Swine Testing (MST) program by adopting visible identification devices (backtags, eartags, or bangle tags) and eliminating program use of the slap tattoo. Lack of adequate identification for tracing MST reactors is acknowledged to be the biggest program barrier.

4. Provide greater incentives to the industry and to owners of infected herds to eliminate the disease. This would include prompt repeal of testing requirements for moving swine interstate when eradication has been achieved. This would primarily involve State action to eliminate test requirements on imported breeding swine. Federal regulations do not require testing of swine originating in validated herds or areas.

5. Develop a program of information and education to enlist industry support for the goal of eradication.

6. Emphasize that after 5 years, the Federal Government would be responsible for surveillance, regulation enforcement, and the dissemination of information. All other aspects of the swine brucellosis program would be the responsibility of the various States.

7. Operate within current swine brucellosis budget levels.

Swine Brucellosis

See attached:

1. Validated Brucellosis-Free States.

2. Time since last known infected herd — shows length of time since the last infected herd was found in each State using intervals of time up to and exceeding 10 years.

3. Number of swine brucellosis cases reported by States by FY.

4. List of regulation and program changes and associated factors that may need to be modified under the proposed 5-year eradication plan.

5. Swine Brucellosis Program Goals — shows current status of each State and estimates when each will achieve Validated Brucellosis-Free area status.
BRUCELLOSIS

Planning Timetable

1. January 22, 1986 — Develop basic assumptions concerning a 5-year plan, using available information from industry.


3. April 1986 — Discuss revised draft with U.S. Animal Health Association (USAHA) Swine Brucellosis Subcommittee at the Livestock Conservation Institute meeting in Omaha.

4. April—October 1986 — Develop final draft of a proposed 5-year plan. Gain Agency concurrence with its basic concept.

5. October 19–26, 1986 — Present proposed plan for consideration at the USAHA meeting in Louisville, Kentucky.

Required Changes:

1. Regulations to require backtags or eartags for identification of adult sows and boars moving to slaughter.

2. Increased attention to regulation enforcement with rigid enforcement of new regulations governing the identification of adult swine for interstate movement.

3. Intensify slaughter surveillance in States with a known prevalence of the disease or in those of unknown status by concentrating on blood and identification collections in major slaughtering establishments where breeding swine from those areas are slaughtered.

4. Regulations to control the interstate movement of feral swine and to prevent the movement of feral swine from areas with known infection.

5. Depopulation required of all herds confirmed infected (B. suis) in States with program (I, II, or Free) with exception of quarantined herds of feral swine.

6. Disseminate information to all States for the promotion of swine brucellosis eradication and program advancement to Validated-free status.

7. Intensify efforts to bring the seven noncooperative States into program (Missouri, Mississippi, New Mexico, Oregon, Tennessee, Texas and West Virginia).

8. Industry should (1) devise aspects, if necessary to assume leadership to encourage States to participate in program, (2) assume leadership in building support for finishing the job in States with programs and to encourage inauguration of program in no program States, (3) assemble and disseminate information on advantages of eradication, cost, foreign markets, etc., (4) assume leadership for the development
REPORT OF THE COMMITTEE

of systems for controlling movements of feral swine for the control and the spread of pseudorabies, as well as swine brucellosis.

9. States should seek State indemnity provisions to support the present level of Federal indemnity for the depopulation of brucellosis infected swine herds.

10. States be encouraged to relax change of ownership testing requirements on breeding stock moving from within free states.

### SWINE BRUCELLOSIS
### VALIDATED BRUCELLOSIS-FREE STATES

<table>
<thead>
<tr>
<th>State</th>
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</tr>
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<td>Utah</td>
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<td>Virgin Islands</td>
<td>March 18, 1966</td>
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<tr>
<td>Arizona</td>
<td>June 13, 1969; reinstated July 1, 1982</td>
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<tr>
<td>California</td>
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<tr>
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200
## SWINE BRUCELLOSIS PROGRAM GOALS
### 5-YEAR PLAN ENDING SEPTEMBER 30, 1990

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X = Status on September 30, 1986
# BRUCELLOSIS

## SWINE BRUCELLOSIS

**TIME SINCE LAST KNOWN INFECTED HERD**

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* = Validated State

June 17, 1986

## LIST OF STATES

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|----------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Alabama        | 1  | 14 | 1  | 2  | 11 | 7  | 3  | 3  |    |    | 2  | 4  | 5  | 3  | 4  | 2  | 6  |
| Alaska         |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Arizona        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Arkansas       |    |    |    |    |    |    |    | 2  | 6  | 3  | 6  | 1  | 5  | 11 | 15 | 2  | 13 | 14 |
| California     |    |    |    |    | 1  |    |    | 1  | 2  | 1  | 1  | 1  |    | 9  | 13 |    |    |
| Colorado       |    |    |    |    | 1  |    |    | 1  |    | 4  | 4  | 1  |    |    | 2  |    |    |
| Connecticut    | 1  | 2  | 5  | 10 | 5  | 6  | 7  | 4  |    |    |    |    |    |    |    |    | 1  |
| Delaware       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 1  |
| Florida        |    | 1  | 7  | 4  | 4  | 9  | 13 | 7  | 2  | 8  | 2  | 5  | 5  | 15 |    |    | 25 |
| Georgia        | 7  | 22 | 28 | 65 | 111| 86 | 91 | 74 | 19 | 7  | 10 | 10 | 25 | 30 | 25 | 28 | 67 |
| Hawaii         | 1  | 7  | 2  | 1  | 1  |    | 1  | 2  |    | 4  | 6  | 8  | 28 |    |    |    |    |
| Idaho          |    |    |    |    |    |    |    |    |    |    |    |    |    | 1  |    |    |    |
| Illinois       |    |    |    |    |    |    |    | 13 | 3  | 9  | 11 | 16 | 12 | 12 | 50 | 59 | 38 | 10 |
| Indiana        |    |    |    |    | 1  |    |    |    |    |    |    |    |    |    | 8  | 29 | 42 | 9  | 17 |
| Iowa           |    |    |    |    |    | 1  |    |    |    |    |    |    |    |    |    |    | 5  | 17 | 38 | 23 | 36 | 115 | 413 |
| Kansas         |    |    |    |    | 1  |    |    |    |    |    |    |    |    |    |    |    |    | 1  | 2  |    |    |
| Kentucky       |    | 1  | 2  | 1  | 2  | 4  | 5  | 13 | 7  | 13 |    |    |    |    |    |    |    |    |
| Louisiana      | 1  | 2  | 1  | 6  | 4  | 3  |    | 1  | 5  | 2  | 6  | 6  |    |    |    |    |    |    |
| Maine          |    | 4  |    |    |    | 1  | 4  | 3  | 1  | 3  | 1  | 8  |    |    |    |    |    |    |
| Maryland       |    | 1  | 1  | 2  | 2  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |    |
| Massachusetts  | 1  | 5  | 6  | 14 | 8  | 15 | 17 | 13 | 17 | 35 | 48 | 31 | 27 | 11 | 1  | 4  |    |
| Michigan       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 1  |
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REPORT OF THE COMMITTEE

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MINUTES OF BRUCELLOSIS COMMITTEE PROCEEDINGS
October 20, 1986

The meeting was called to order by Chairman John B. Armstrong.

Dr. Granville Frye presented a status report on the National Brucellosis Eradication Program. He mentioned that, as of 9/30/86, there are 23 Class Free States, 1 Class Free-A State, 17 Class A States, and 2 Class B-C States and 2 Class C States.

Mr. Phil Ladd gave a report on the Brucellosis Information System (BIS), and its expected role during the transition period (1987–1990) and after 1990. He said that the goal was to continue to increase its use and eventually to replace the Harris equipment with microcomputers in the States, thus shifting the data base to the States.

Mr. Bill Gallagher proposed a resolution that a standardized indemnity payment for reactors ($150.00 regardless of breed and registration status) and for depopulation ($500.00/head) in Class Free and A States, be implemented.

Dr. J. E. Slauter resolved that a sliding scale payment schedule for
BRUCELLOSIS

depopulation be adopted, depending on State classification:

Class Free: Appraisal value up to $1,000.00 minus salvage value
Class A: $150.00/hd
Class B: $75.00/hd
Class C: $50.00/hd

Dr. Robert Hartin resolved that the fee basis calfhood vaccination program be re-established in high incidence states.

Dr. Richard Crawford reported the research finds at Texas A and M of the effects on the simultaneous administration of anthelmintics and St. 19 vaccine in adult animals. He concluded that it was a compatible health management practice, without promoting persistent antibody titers, to do that.

Dr. Robert Brown reported the Auburn University study on the progeny of brucellosis infected cows. They were not able to demonstrate the latency of infection in the 164 heifers and 69 bulls included in the project.

Dr. Brian Espe gave a report on an earlier meeting of the Education Subcommittee. It was recommended that the individual States provide a regular roster of quarantined herd owners to the Kerr Foundation and LCI to facilitate the distribution of educational materials to them. It was also recommended that the auction markets be explored as a vehicle for the dissemination of information.

Mr. Lou Pollock gave a report on the Particle Concentration Fluorescence Immunoassay (PCFIA) test. Data presented concerning the sensitivity and specificity of the data of the test demonstrated promise. Dr. Garry Adams of the Scientific Advisory Committee recommended further study on the test before it was adopted as an official testing method.

Mr. John Armstrong emphasized that two essential criteria must be met, if we are to continue to make progress in the Brucellosis Eradication Program:

1. Must have the cooperation of the industry.
2. All changes in policy and protocol must be scientifically valid.

Mr. Joe Huff of the Colorado Serum Company, and Dr. Miles Berry of NVSL expressed the need for an additional 10% allowance (beyond the 3-10 billion/dose range) in their viability counts of the Brucella abortus St. 19 vaccine prior to its distribution to the field.

Dr. N. R. Swanson proposed a change in the testing requirements of commuting rodeo bulls.

Mr. George Hall proposed that the testing requirements on slaughter bulls moving through the markets be altered.

Dr. J. Lee Alley opened further discussions on the previous years motion concerning the direct movement requirements of slaughter cattle and restricted cattle to feedlots.

Representing the Western States Livestock Health Association, Dr.
Jack Armstrong made the resolution that (effective 1/1/87) heifer calves moving out of Class B and C States meet the same requirements as those out of Class Free and A States. Mr. Al Keating reported, from the proceedings of the Regional LCI Conference in Memphis, that 24 State Veterinarians have agreed to individually increase their restrictions on all heifers moving out of Class B and C States. Dr. Garry Adams of the Scientific Advisory Committee, stated it was epidemiologically valid to adopt the same requirements on heifers moving out of quarantined herds in all States (regardless of classification).

Mr. J. O. Pearce of the Heifer Syndrome Subcommittee, reported on their two meetings this past year, recommended that all heifers in quarantined herds in all States be treated the same, and stated the necessity of identifying those heifers on farm or at their point of concentration.

Dr. Brian Espe and Dr. Dave Reed gave an update on the progress in the development of a new vaccine against brucellosis using genetic engineering.

Dr. J. F. Drazek reviewed some of the problems that were encountered in New York during the eradication of brucellosis there.

Dr. Paul Doby gave a report on the proceedings of the Swine Brucellosis Subcommittee. He mentioned that continued progress has been made with only 21 infected herds being disclosed last year in the United States.
The diagnostic section of the National Reference Center for Leptospirosis is a part of the Diagnostic Bacteriology Laboratory of National Veterinary Services Laboratories located in Ames, Iowa. Services provided by the Reference Center include serologic testing for export and diagnostic purposes, isolation and serotyping, production and maintenance of reference leptospira cultures and antisera, provision of media and other reagents, epidemiological consultation, and training of personnel from other diagnostic laboratories. Emphasis is placed on furnishing diagnostic support for suspected cases of leptospirosis in domestic animals.

During the period of September 1, 1985, to August 31, 1986, 4,777 serum samples were received for serologic testing. Of these, 1,205 were submitted for testing in order to satisfy export requirements and 3,572 were submitted for diagnostic tests from suspected cases of leptospirosis or for surveillance purposes. A total of 42,294 microscopic agglutination tests (MAT) were performed on the serum samples. Summaries of MAT results for diagnostic submissions are presented in Tables 1 through 4. Antigens used for diagnostic tests were australis Ballico (AUS), autumnalis Akiyama A (AUT), ballum S102 (BAL), bataviae Van Tienen (BAT), canicola Hond Utrecht IV (CAN), grippotyphosa Andaman (GRI), hardjo Hardjoprajitno (HAR), copenhageni M20 (ICT), pomona Pomona (POM), pyrogenes Salinem (PYR), and tarassovi Perepelicin (TAR). Sera which exhibited 50% or more agglutination at the 1:100 or higher dilution are reported as positive. Leptospira antibodies were detected in sera from 43.4% of the cattle, 33.3% of the swine, 51.2% of the horses, and 7.9% of the sheep and goats for which diagnostic submissions were received. The results do not represent the true prevalence of leptospirosis in these species. MAT results for sera from animals intended for export are presented in Tables 5 and 6. Antigens and serum dilutions were according to the requirements of the importing countries.

Two hundred eighty-six submissions with 718 specimens were received for leptospira isolation. The majority of these specimens were submitted by diagnosticians who were investigating abortion cases. Submissions were received from Florida, Iowa, Kansas, Maryland, Minnesota, Mississippi, Nebraska, Ohio, Oregon, Pennsylvania, Puerto Rico, South Dakota, Texas, and Washington. The number of submissions received for each species is as follows: 150 porcine, 114 bovine, 13 ovine, 1 caprine, 1 deer, 5 canine, and 2 equine. Specimens submitted included aborted fetal tissues, urine, pericardial and thoracic fluids, blood, liver, and kidney.
Eighteen leptospira cultures were submitted for serotyping by agglutinin-absorption tests. The cultures were isolated from 4 species in 3 states and 3 foreign countries. The sources, histories, and serovars identified are shown in Table 7.

A total of 10,868 ml of rabbit antisera has been produced and lyophilized in 2 ml aliquots for 74 reference leptospira cultures. Antisera for 122 serovars were produced in fiscal year 1985, making a total of 196 reference antisera currently available. The antisera are used in the agglutinin-absorption test for serotyping purposes and are used as positive controls in the MAT.

Requests for reagents were received from 33 states and 9 foreign countries. Two hundred fifty-eight vials of antisera, 489 leptospira cultures, 282 vials of transport medium, and 351 vials of culture media were provided to diagnostic laboratories for use in serologic tests and isolation work.

Epidemiological consultation was requested in 34 suspected cases of leptospirosis. The requests came from diagnosticians and practitioners located in Arkansas, Connecticut, Iowa, Kansas, Maine, Minnesota, Michigan, Nebraska, North Carolina, North Dakota, Ohio, Texas, Washington, Ecuador, Honduras, and Panama. Species involved included cattle, swine, sheep, horses, elk, and other wildlife.

Training was provided to 11 people with interests in leptospira serology, isolation, and/or media preparation. The trainees had backgrounds in research, epidemiology, diagnostics, and import-export work and were from Texas, Maryland, Egypt, Taiwan, Mexico, Morocco, Korea, and Mali.

At the 1985 meetings of the United States Animal Health Association Leptospirosis Committee and the American Association of Veterinary Laboratory Diagnosticians Interpretive Serology Committee, concerns were expressed about the variability in MAT results from different laboratories. In response to these concerns, the Reference Center provided a check test to diagnostic laboratories on a voluntary basis. The check test consisted of 20 animal sera to be titrated against 5 leptospira antigens. Analysis of the results produced a measurement of variability in the test results of participating laboratories.

Three developmental projects are in progress at the diagnostic section of the Reference Center. The first, a survey to estimate prevalence of leptospira serovars in mature cattle, has resulted in collection of 2,643 blood and kidney specimens as of August 31, 1986. Thirty-four isolates have been obtained from kidney tissues. Of 2,400 serum samples tested by MAT with 12 antigens, 1,226 (51%) have been positive at dilutions of 1:100 or greater for 1 or more antigens.

A study to determine the effect of isolation of several days delay between tissue collection and inoculation into culture media is also in progress. As of August 31, 1986, 11 isolates have been obtained from 250 bovine
kidneys collected in an Iowa slaughterhouse. Preliminary results indicate that leptospires can be isolated from properly prepared and refrigerated kidney tissues as long as 8 to 9 days after collection.¹¹

Work is continuing on the development of a fluorescent antibody conjugate for general diagnostic use. Preliminary results from evaluation of the first lot of conjugate indicate that 3+ fluorescence¹² could be attained from 12 leptospira stock cultures and from infected hamster kidney tissues. Antisera are being prepared for a second lot of conjugate in an attempt to increase the intensity of fluorescence of leptospires and eliminate background fluorescence.

REFERENCES

Table 1: MAT Results on Diagnostic Submissions from Cattle

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% Positive of Total No. of Sera: 43.4 0.2 1.5 5.8 1.2 12.5 4.7 24.5 21.0 17.6 3.0 1.8

*Sera which exhibited 50% or more agglutination at 1:100 or higher dilution were considered positive; 57% of positive sera were positive for more than 1 antigen.
Table 2: MAT Results on Diagnostic Submissions from Swine

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% Positive of Total No. of Sera: 33.3 1.3 4.5 2.6 0.4 5.4 3.3 8.3 18.6 6.3 2.4 0.1 5.0

*45% of positive sera were positive for more than 1 antigen.

**Only 187 sera from 15 herds were tested with Bratislava antigen.
Table 3: MAT Results on Diagnostic Submissions from Horses

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<tr>
<td>PR</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>AUS 1 AUT 1 BAL 1 BAT 1 CAN 1 GRI 1 HAR 1 ICT 1 POM 1 PYR 1 TAR 1</td>
</tr>
<tr>
<td>Totals</td>
<td>17</td>
<td>43</td>
<td>22</td>
<td>AUS 7 AUT 8 BAT 2 CAN 5 GRI 3 HAR 10 ICT 3 POM 4 PYR 0 TAR 1</td>
</tr>
</tbody>
</table>

% Positive of Total No. of Sera  
51.2 0 16.3 18.6 4.7 11.6 11.6 7.0 23.3 7.0 9.3 0  

*60% of positive sera were positive for more than 1 antigen.
Table 4: MAT Results on Diagnostic Submissions from Sheep and Goats

<table>
<thead>
<tr>
<th>State</th>
<th>No. of Herds</th>
<th>No. of Sera</th>
<th>No. of Positives*</th>
<th>No. of Positives Per Antigen</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>ME</td>
<td>3</td>
<td>18</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>MD</td>
<td>3</td>
<td>53</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>MO</td>
<td>1</td>
<td>11</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>NC</td>
<td>1</td>
<td>52</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>WV</td>
<td>1</td>
<td>6</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>PR</td>
<td>35</td>
<td>189</td>
<td>16</td>
<td>1 4 4 3 1 1 9 3</td>
</tr>
<tr>
<td>VI</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>46</td>
<td>331</td>
<td>26</td>
<td>1 0 4 4 10 8 8 18 8 3 0</td>
</tr>
</tbody>
</table>

% Positive of Total No. of Sera

| | 7.9 | 0.3 | 1.2 | 1.2 | 3.0 | 2.4 | 2.4 | 5.4 | 2.4 | 0.9 | 0 |

*65% of positive sera were positive for more than 1 antigen.
Table 5: MAT Results on Submissions from Cattle Intended for Export

| State | No. of Herds | No. of Sera | No. of Positives* | BAL | CAN | GRI | HAR | ICT | POM | PYR | SEJ+ |
|-------|--------------|-------------|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| IL    | 3            | 128         | 21               | 18  | 4   |     |     |     |     |     |     |     |
| IA    | 2            | 2           | 1                |     |     |     |     |     |     |     |     |     |
| KS    | 1            | 7           | 0                |     |     |     |     |     |     |     |     |     |
| KY    | 2            | 4           | 0                |     |     |     |     |     |     |     |     |     |
| ME    | 27           | 127         | 6                |     |     |     |     |     |     |     |     |     |
| MD    | 2            | 14          | 11               | 8   | 2   | 4   | 9   | 7   |     |     |     |
| MN    | 13           | 30          | 6                |     |     |     |     |     |     |     |     | 7   |
| MS    | 1            | 7           | 7                |     |     |     |     |     |     |     |     |     |
| MO    | 2            | 5           | 3                |     |     |     |     |     |     |     |     |     |
| NE    | 13           | 23          | 5                |     |     |     |     |     |     |     |     |     |
| ND    | 14           | 28          | 7                | 7   |     |     |     |     |     |     |     |     |
| OH    | 2            | 44          | 0                |     |     |     |     |     |     |     |     |     |
| OK    | 3            | 50          | 7                |     |     |     |     |     |     |     |     |     |
| OR    | 1            | 1           | 0                |     |     |     |     |     |     |     |     |     |
| PA    | 1            | 1           | 0                |     |     |     |     |     |     |     |     |     |
| RI    | 1            | 17          | 0                |     |     |     |     |     |     |     |     |     |
| SD    | 2            | 3           | 0                |     |     |     |     |     |     |     |     |     |
| TX    | 4            | 36          | 5                | 1   |     |     |     |     |     |     |     |     |
| VT    | 1            | 30          | 3                |     |     |     |     |     |     |     |     |     |
| Totals| 95           | 557         | 82               | 29  | 12  | 8   | 18  | 11  | 22  | 1   | 7   |     |

% Positive of Total No. of Sera

|          | 14.7 | 5.2  | 2.2  | 1.4  | 3.2  | 2.0  | 3.9  | 0.2  | 1.3  |

*22% of positive sera were positive for more than 1 antigen.

**Antigens used were specified by the importing country; none of these sera were tested with all antigens listed.

+ Sejroe M84.
Table 6: MAT Results on Sera from Swine, Horses, Sheep and Goats Intended for Export

<table>
<thead>
<tr>
<th>State</th>
<th>No. of Herds+</th>
<th>No. of Sera</th>
<th>No. of Positives*</th>
<th>No. of Positives Per Antigen**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>CAN</td>
<td>GRI</td>
</tr>
<tr>
<td>CA</td>
<td>55 (H)</td>
<td>145</td>
<td>25</td>
<td>6</td>
</tr>
<tr>
<td>CA</td>
<td>2 (G)</td>
<td>9</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>FL</td>
<td>2 (H)</td>
<td>6</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>IL</td>
<td>12 (S)</td>
<td>306</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>IL</td>
<td>2 (G)</td>
<td>33</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>IN</td>
<td>2 (S)</td>
<td>15</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>KS</td>
<td>1 (Sh)</td>
<td>9</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>KY</td>
<td>5 (H)</td>
<td>10</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>MO</td>
<td>1 (H)</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>NJ</td>
<td>2 (H)</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>NY</td>
<td>3 (H)</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>OK</td>
<td>3 (H)</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>TX</td>
<td>9 (H)</td>
<td>25</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>TX</td>
<td>1 (G)</td>
<td>5</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>VA</td>
<td>2 (H)</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>102</td>
<td>575</td>
<td>38</td>
<td>9</td>
</tr>
</tbody>
</table>

% Positive of Total No. of Sera

<table>
<thead>
<tr>
<th></th>
<th>Total No. of Sera</th>
<th>CAN</th>
<th>GRI</th>
<th>HAR</th>
<th>ICT</th>
<th>POM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>6.6</td>
<td>1.6</td>
<td>0.3</td>
<td>0.9</td>
<td>4.7</td>
</tr>
</tbody>
</table>

*28% of positive sera were positive for more than 1 antigen.

**Antigens used were specified by the importing country.

+H = horses, S = swine, G = goats, Sh = sheep.
Table 7: Leptospira Cultures Submitted for Serotyping

<table>
<thead>
<tr>
<th>No. of Cultures</th>
<th>State or Country</th>
<th>Source</th>
<th>Submitter</th>
<th>Serogroup/Serovar</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Minnesota</td>
<td>Aborted porcine fetus</td>
<td>C. A. Kirkbride SDSU</td>
<td>Pomona/Kennewicki</td>
</tr>
<tr>
<td>1</td>
<td>Mexico</td>
<td>Rat; epidemiologic survey</td>
<td>J. Z. Velazquez Universidad Autonoma de Yucatan</td>
<td>Semaranga/Patoc</td>
</tr>
<tr>
<td>2</td>
<td>Texas</td>
<td>Raccoons; epidemiologic survey</td>
<td>Hugh Mainzer TX A&amp;M Dept. Vet. Public Health</td>
<td>Grippotyphosa/Grippotyphosa</td>
</tr>
<tr>
<td>7</td>
<td>Ecuador</td>
<td>Rats; epidemiologic survey</td>
<td>Washington Yepez Instituto Nacional de Higiene</td>
<td>*</td>
</tr>
<tr>
<td>1</td>
<td>Washington</td>
<td>Urine; dairy herd abortion</td>
<td>B. J. Edmundson State-Fed. Lab.</td>
<td>*</td>
</tr>
<tr>
<td>6</td>
<td>Zimbabwe</td>
<td>Cattle; slaughterhouse</td>
<td>P. G. Gamble Vet. Res. Lab.</td>
<td>*</td>
</tr>
</tbody>
</table>

*These cultures were not identified as of publication date.
REPORT OF THE COMMITTEE ON LEPTOSPIROSIS

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Vice Chairman: Dr. J. R. Cole, Jr., Tifton, GA

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The USAHA Committee on Leptospirosis met on October 22, 1986, with 30 members and guests in attendance.

Dr. Rance LeFebvre of the Research Section (NADC-ARS) of the National Leptospirosis Reference Center updated the Committee on the section's 1985–86 activities. These included: (1) continuation of typing field isolates by restriction endonuclease analysis, (2) studies on the pathogenicity of L. hardjo-bovis in vaccinated and unvaccinated pregnant animals, (3) monoclonal antibody development, (4) characterization of antigens including DNA probes of L. hardjo-bovis, hardjo-pragitno and pomona, and (5) continuation of the enlargement of the genetic library of leptospiral DNA.

Dr. David Miller of the Diagnostic Section (NVSL-APHIS) of the Center updated the Committee on the 1985–86 activities of the section. Summaries of the activities included: (1) serology, (2) isolations and serotyping, (3) antisera production, (4) reagents dispensed, and (5) consultations and training. Dr. Miller also reported on the Bovine Prevalence Survey, indicating that to date 3,036 specimens collected by FSIS personnel have been received from 49 states. Forty-two isolations of leptospires (1.4%) have been made and 2,393 have been tested for leptospiral antibodies. A total of 1,226 (51.2%) of these sera had titers of 1:100 or greater against the nine serovars tested. This project will continue until about 5,000 specimens have been received. Dr. Miller also reported on a serological check test that had been sent to 36 diagnostic laboratories. Final results of this survey are being compiled and will be sent to the participating laboratories in the near future. A questionnaire accompanying the check test samples indicated a wide diversity of procedures were used. This suggests that a standardization of testing procedures is needed.

Dr. Muhammad A. Khan of the University of Minnesota presented a preliminary report on the prevalence of leptospiral antibodies in equine sera tested by the Minnesota Veterinary Diagnostic Laboratory.

Dr. Lyle Hanson of the University of Illinois reported on a serological evaluation conducted on 9,000 sera collected from apparently normal Illinois swine. The sera were tested by the MA procedure using the following serovars: bratislava, canicola, grippotyphosa, pomona and ic-
REPORT OF THE COMMITTEE

terohemorrhagiae. The highest reaction rate, at titers of 1:100 or greater, was 5.5% for bratislava and less than 1% for the remaining serovars. A total of 235 diagnostic swine sera from 33 herds with reproductive problems were tested against the same serovars. Twenty-two percent of these sera were positive to bratislava and less than 3% reacted to the remaining serovars. Dr. Hanson indicated that reports from Northern Ireland suggest that swine are a carrier host for bratislava.

Test of sera from swine producers and swine packing plant workers revealed the presence of bratislava antibodies in some of these individuals. This further points out the need for regulatory personnel, veterinarians and livestock producers to be aware of the potential danger of leptospiral infections which may be contracted when working with cattle and swine.

Dr. John Cole of the University of Georgia reported on a study conducted in three month old pigs which indicated a wide variation of antibody response among the vaccinated pigs. This variation should not be interpreted as lack of protection.
FACTORS AFFECTING SOMATIC CELL COUNTS IN MILK

Robert J. Harmon, Ph.D.
Associate Professor of Animal Sciences
University of Kentucky

With the advent of electronic somatic cell counting equipment, somatic cell counts (SCC) are readily available to most dairymen today on a monthly basis through the Dairy Herd Improvement (DHI) program. A large volume of data are now available on large numbers of cows concerning factors affecting SCC in milk. When these data are combined with bacteriological culture results one can get a reasonable idea which factors are of greatest importance and may put to rest some misconceptions concerning changes in SCC.

Milk somatic cells are primarily leucocytes or white blood cells which include macrophages, lymphocytes and neutrophils. Recent studies identifying cell types in milk have shown that epithelial cells are rarely found in any udder secretions including those from the dry gland and range from 0 to 7% of the cell population. Thus increases in SCC at the end of lactation are not due to sloughing epithelial cells. During inflammation the major increase in SCC is due to the influx of neutrophils into the milk. At this time over 90% of the cells may be neutrophils.

Infection Status

The major factor affecting SCC is an infection of the mammary gland. This holds true at the quarter, cow, or bulk tank level. Eberhart and coworkers studied infection prevalence in 80 herds and related this to bulk tank SCC (BTSCC) which ranged from 103,000 to 1,591,000 cells/ml. Table 1 shows estimates of infection prevalence by major pathogens and production losses from this study. It becomes quite obvious that an increase in BTSCC is related to increased infection prevalence and decreased milk production. An analysis of these data showed that infection prevalence was the major determinant of BTSCC.

At the cow and quarter level the normal SCC is generally below 200,000 but may be below 100,000 in first lactation animals. An elevation above this level is abnormal and an indication of inflammation in the udder. The most common organisms that infect the gland can be divided into two groups: the major pathogens and minor pathogens. The major pathogens cause the greatest SCC increase and include Staphylococcus aureus, Strep-tococcus agalactiae, coliforms, and other streptococci. The minor pathogens (Corynebacterium bovis and coagulase — negative staphylococci) usually cause a 2 to 3-fold increase in SCC over that of uninfected quarters. Most studies would indicate that the use of the cell count alone to classify quarters as infected or uninfected results in some degree of error due to false positives and false negatives. These errors may, in part, be due to the normal fluctuation of SCC observed throughout the course of an
infection. Some examples of SCC changes with time during *S. aureus* infections in the University of Kentucky herd are shown in Table 2. It becomes apparent that the SCC in infected quarters does not remain static but tends to fluctuate. In chronic infections SCC and bacterial numbers both tend to fluctuate up and down with time.\(^{10}\) Table 2 also shows variation in SCC in uninfected quarters but the SCC still remains below 200,000.

Magnitude of SCC responses to major pathogens vary from cow to cow and it does not seem possible to differentiate between the types of pathogens by SCC alone.\(^{2}\) Schultz\(^ {14}\) reported that it may take days, weeks, or longer for SCC to decrease after the pathogens have been eliminated from the gland. One would also expect that the SCC in the bucket or composite milk would be related to the number of quarters infected and the amount of milk being produced by each. However, if all quarters of a cow are uninfected one would generally expect SCC below 200,000 in the bucket milk.

The DHI program has adopted an SCC scoring system\(^ {13}\) that divides the SCC of composite milk into 10 categories from 0 to 9 (Table 3). This system has an advantage over bulk tank SCC since changes in the SCC of a small number of cows will not markedly change the herd average score. About 50% of the cows are above and 50% below the herd average score. Both the BTSCC and herd average SCC score indicate the state of udder health in the herd and should be used to monitor trends and alert the dairyman to problems. Treatment based solely on individual SCC has been shown to be impractical.\(^ {18}\)

**Age and Stage of Lactation**

It has generally been observed that SCC increases with advancing age and stage of lactation. However, work by Eberhart and coworkers\(^ {3}\) showed that if cows are separated into groups by infection status, it becomes obvious that there is little change in SCC either in late lactation or as a cow ages in uninfected cows (Tables 4 and 5). Bodoh et al.\(^ {1}\) found a rise in SCC at the end of lactation only after production had dropped below 4 kg per day, but the infection status in these animals was not determined.

Another recent study\(^ {16}\) showed that the SCC of milk from uninfected quarters rose from 83,000 at 35 days postpartum to 160,000 by 285 days. However, *S. aureus* infected quarters rose from 234,000 to 1,000,000 over the same period. All quarters, regardless of infection status had elevated SCC immediately postpartum, but those quarters with no infections or with minor pathogen infections showed a rapid decline in SCC to 35 days postpartum. In addition, uninfected quarters showed little change in SCC with increasing number of lactations. Thus the major influence of parity and stage of lactation on SCC is related to intramammary infection.

**Stress and Season**

Stresses of various types have been implicated in causing increases in
FACTORS AFFECTING SOMATIC CELL COUNTS IN MILK

SCC. However, attempts to experimentally induce SCC changes in uninfected cows by injection of ACTH or corticosteroids or by placing animals in environmentally controlled chambers have shown only modest or no effects on milk SCC. It has also been reported that estrus has no effect on SCC.

Somatic cell counts are generally lowest in the winter and highest in the summer. This coincides with an increased incidence of clinical mastitis in the summer months that has been reported in several studies. Smith et al. showed that rate of infection by environmental pathogens was highest in the summer and coincided with highest numbers of coliforms in bedding. They suggested that the stress of high temperatures and humidity could have increased the susceptibility to infection as well as increasing the numbers of pathogens to which cows were exposed. These findings support the concept that temperature stress per se is not the cause of increased SCC but the increased SCC is a result of more new infections and clinicals during the summer months.

Other Factors

There is a normal (diurnal) variation in SCC with the fraction of milk collected throughout a milking and during the time between milkings. In general cell counts are highest in the strippings and lowest immediately before milking. The elevated SCC may persist for up to 4 hours after milking and then gradually decline. This difference in high and low SCC has been shown to vary from 4 to 70 fold in individual quarters. Since there is a high correlation (r = 0.86) between SCC in foremilk and composite or bucket milk, either of these types of samples should be routinely used to collect SCC data.

Summary

The major factor affecting SCC at the herd and cow level is the presence of intramammary infections. There is little evidence that any factor other than normal diurnal variation has a major influence on SCC in the absence of intramammary infection.

REFERENCES


FACTORS AFFECTING SOMATIC CELL COUNTS IN MILK

Table 1. Estimated infection prevalence and losses in milk production associated with elevated bulk tank SCC.

<table>
<thead>
<tr>
<th>Bulk Tank SCC (1000's/ml)</th>
<th>Percent Infected Quarters in Herd</th>
<th>Percent Production Loss*</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>500</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>1000</td>
<td>32</td>
<td>18</td>
</tr>
<tr>
<td>1500</td>
<td>48</td>
<td>29</td>
</tr>
</tbody>
</table>

From Eberhart et al.4

*Production loss calculated as a percent of production expected at 200,000 cells/ml.

Table 2. Somatic cell counts in uninfected quarters or quarters infected with S. aureus.

<table>
<thead>
<tr>
<th>Date</th>
<th>Cow 46</th>
<th>Cow 834</th>
<th>Cow 602</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Infected Qtr.</td>
<td>Uninfected Qtr.</td>
<td>Infected Qtr.</td>
</tr>
<tr>
<td>9-16</td>
<td>Fresh</td>
<td>Fresh</td>
<td>621</td>
</tr>
<tr>
<td>9-30</td>
<td>419a</td>
<td>169</td>
<td>1484</td>
</tr>
<tr>
<td>10-14</td>
<td>151</td>
<td>90</td>
<td>940</td>
</tr>
<tr>
<td>10-28</td>
<td>203</td>
<td>117</td>
<td>838</td>
</tr>
<tr>
<td>11-18</td>
<td>350</td>
<td>54</td>
<td>193</td>
</tr>
<tr>
<td>12-09</td>
<td>243</td>
<td>117</td>
<td>220</td>
</tr>
<tr>
<td>1-06</td>
<td>278</td>
<td>128</td>
<td>385</td>
</tr>
<tr>
<td>2-04</td>
<td>1551</td>
<td>99</td>
<td>431</td>
</tr>
<tr>
<td>3-04</td>
<td>377</td>
<td>84</td>
<td>471</td>
</tr>
</tbody>
</table>

aAll SCC × 10³/ml.
bNegative culture
Table 3. Estimated differences in lactation milk yield associated with an increase in somatic cell count score.

<table>
<thead>
<tr>
<th>Lactation Average SCC Score</th>
<th>Average SCC (thousands/ml)</th>
<th>Difference in Milk Yield*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lactation 1 (lbs/305 days)</td>
</tr>
<tr>
<td>0</td>
<td>12.5</td>
<td>—</td>
</tr>
<tr>
<td>1</td>
<td>25</td>
<td>—</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>—200</td>
</tr>
<tr>
<td>4</td>
<td>200</td>
<td>—400</td>
</tr>
<tr>
<td>5</td>
<td>400</td>
<td>—600</td>
</tr>
<tr>
<td>6</td>
<td>800</td>
<td>—800</td>
</tr>
<tr>
<td>7</td>
<td>1600</td>
<td>—1000</td>
</tr>
</tbody>
</table>

*Comparisons are with lactation yields at SCC scores of 2. From Raubertas and Shook.13

Table 4. Mean somatic cell counts by cow age and infection status.

<table>
<thead>
<tr>
<th>Age</th>
<th>All Cows</th>
<th>No Infect.</th>
<th>Minor Infect.</th>
<th>Major Infect.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>232</td>
<td>126</td>
<td>190</td>
<td>614</td>
</tr>
<tr>
<td>3</td>
<td>314</td>
<td>149</td>
<td>218</td>
<td>661</td>
</tr>
<tr>
<td>4</td>
<td>390</td>
<td>148</td>
<td>233</td>
<td>753</td>
</tr>
<tr>
<td>5</td>
<td>564</td>
<td>180</td>
<td>308</td>
<td>977</td>
</tr>
<tr>
<td>6</td>
<td>544</td>
<td>194</td>
<td>322</td>
<td>880</td>
</tr>
<tr>
<td>7</td>
<td>654</td>
<td>251</td>
<td>320</td>
<td>986</td>
</tr>
<tr>
<td>&gt;7</td>
<td>868</td>
<td>113</td>
<td>519</td>
<td>1207</td>
</tr>
</tbody>
</table>

Data from 3130 cows. From Eberhart et al.3
FACTORS AFFECTING SOMATIC CELL COUNTS IN MILK

Table 5. Mean somatic cell counts by days in milk and infection status.

<table>
<thead>
<tr>
<th>Days in Milk</th>
<th>All Cows</th>
<th>No Infect.</th>
<th>Minor Infect.</th>
<th>Major Infect.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SCC in 1000's/ml</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-49</td>
<td>380</td>
<td>164</td>
<td>247</td>
<td>839</td>
</tr>
<tr>
<td>50-99</td>
<td>429</td>
<td>138</td>
<td>286</td>
<td>861</td>
</tr>
<tr>
<td>100-149</td>
<td>498</td>
<td>125</td>
<td>240</td>
<td>1068</td>
</tr>
<tr>
<td>150-199</td>
<td>399</td>
<td>126</td>
<td>295</td>
<td>735</td>
</tr>
<tr>
<td>200-249</td>
<td>452</td>
<td>208</td>
<td>240</td>
<td>902</td>
</tr>
<tr>
<td>250-299</td>
<td>445</td>
<td>139</td>
<td>267</td>
<td>758</td>
</tr>
<tr>
<td>&gt;300</td>
<td>634</td>
<td>165</td>
<td>374</td>
<td>1031</td>
</tr>
</tbody>
</table>

Data from 3130 cows. From Eberhart et al.³
MASTITIS IN BEEF CATTLE
Duane N. Rice, DVM, E. Denis Erickson, DVM, Ph.D., Gary Ross, DVM, and John Vetterling, Ph.D.

Clinical and experimental observations have shown that mastitis in beef cattle frequently results in acute and chronic disease, occasional death loss, premature culling, and loss in weaning weights of calves nursing affected cows.\(^1,2,3,4,5\) In spite of this, very little research has been directed toward characterizing the disease or its economic impact. Pilot studies, which we have conducted, confirm the existence of the disease in Nebraska herds and indicate a bacterial etiology comparable to the syndrome in dairy cattle.\(^6\)

Working under the postulate that mastitis is a bacterial infection of the beef cow resulting in suboptimal weaning weights of calves, chronic udder damage, premature culling, and a variety of associated economic costs, we have initiated trials to test this hypothesis. For a period of several years, a specific group of cows at the USDA-ARS, U.S. Meat Animal Research Center (MARC) will be surveyed using the California Mastitis Test (CMT). Milk from reactor quarters of affected cows will be submitted for microbiological culture. These procedures will begin on first calf heifers and surveillance will continue on the same group throughout the experiment. These data will be correlated with cow age, onset of infection, lactation history, cow culling, and calf weaning weights. Individual cows will be allocated randomly to one of three trial groups. At weaning, the first group will receive no treatment and the second group will receive a commercially prepared penicillin-streptomycin dry cow infusion (Quartermaster, The Upjohn Company) in all quarters. The third group will have a plastic coil intramammary device\(^7\) inserted and the same dry cow infusion given to group II.

We anticipate that definition of this syndrome will bring its importance to the attention of those concerned and will form the basis for control measures.

REFERENCES

From the Department of Veterinary Science, University of Nebraska, Lincoln, Nebraska 68583-0905 (Rice, Erickson) and from the USDA-ARS, U.S. Meat Animal Research Center, Clay Center, Nebraska 68933 (Ross, Vetterling).
MASTITIS IN BEEF CATTLE


6. Rice, D. N., Erickson, E. D.: Unpublished data, University of Nebraska, Lincoln, NE.

REPORT OF THE COMMITTEE ON MASTITIS

Chairman: Dr. C. A. Jordan, Morgan Center, VT
Vice Chairman: Dr. T. J. Fuhrmann, Tempe, AZ
Clerk: Richard S. Sechrist

Mr. J. Adams, VA; Dr. J. M. Arnoldi, WI; Dr. Allen N. Bringe, WI; Dr. M. L. Crandall, MD; Dr. D. F. Dineen, ME; Dr. N. E. East, CA; Mr. F. D. Gregerson, CO; Mr. J. W. Groff, PA; Dr. D. E. Jasper, CA; Dr. C. N. Jewett, AR; Dr. C. A. Kirkbride, SD; Dr. J. S. McDonald, WA; Brig. Gen. T. G. Murnane, TX; Dr. J. E. Post, CT; Dr. D. N. Rice, NE; Mr. R. S. Sechrist, OH; Dr. F. E. Sterner, CO; Dr. D. U. Walker, VT; Dr. R. F. Weidner, IL.

The meeting was held at 1:30 p.m. in Louisville, Kentucky, on October 22, 1986.

The October 30, 1985 Committee report and the report of the Committee's meeting held February 19, 1986, in Columbus, Ohio, were accepted with minor corrections.

Richard Sechrist, Executive Secretary of DHIA, in reporting for the Mission Statement Committee, presented two Mission Statements for discussion purposes. After making some additions and combining the two, the Committee approved the following: "Mission of the USAHA Mastitis Committee."

Whereas the stated objective of USAHA is to prevent, control and eliminate livestock diseases of which mastitis costs ranchers, farmers and consumers approximately $2 billion per year. Its 1,300 members are state and federal animal health officials, practicing veterinarians, extension veterinarians, livestock producers, etc.

Therefore the Mission of the Mastitis Committee of the United States Animal Health Association shall be to advise the association in all matters pertaining to mastitis, a commercially significant disease of the mammary gland affecting dairy cattle and other domestic livestock. The Committee provides communications and educational resources to members of the association, a majority of whom have livestock health responsibilities at a state level; the Committee serves as a forum for the consideration of all facets of mastitis research, education, and control; it cooperates with all other agencies which have interests in mastitis; the Committee is a resource for program planning, including state mastitis control programs.

Mr. John Adams of the National Milk Producers Federation reviewed a survey conducted in 1985 by the Interstate Milk Shippers Committee concerning "Monetary Incentive Quality Programs of Dairy Cooperatives." The survey indicated that incentives generally are used to encourage quality, but penalties are more greatly used to reduce antibiotics in milk. Many reasons were given by milk cooperatives for initiating
quality incentive premiums including to reward top quality producers, to improve raw quality which in turn would increase shelf life, quality of finished product and yields, especially cheese yields. Almost all cooperatives have some type of penalty program for antibiotic contaminated milk. Also, a violation of the antibiotic program and quality programs in general usually deprives the dairyman of any protein premium. The survey indicates that quality incentives have had a significant impact on improving quality of milk, in some cases more than a 20% improvement. Dairy farmers believe that these same programs have been the stimulus to work to reduce mastitis in their herds.

Dr. Robert Harmon reviewed his paper, “Factors Affecting Somatic Cell Counts in Milk,” which you have just heard during this morning’s session. During the discussion, it was brought out that there is an inverse relationship between the somatic cell count and milk production. Older cows have more mastitis infections with these infections causing higher cell counts than younger cows. Stress or estrus in non-infected cows does not produce high somatic cell counts. Treatment during lactation is not recommended on the basis of cell counts alone. Treatment should be confined to clinical cases.

Dr. Duane Rice led a discussion of his paper, “Mastitis in Beef Cattle,” which you have just heard. This study will be going on for the next three or four years at the United States Meat Animal Research Center in Nebraska. Dr. Rice plans to keep the Committee fully informed.

As part of our program to encourage the development of new State Mastitis Control programs and to strengthen those now in existence, Dr. Donald Lein of the New York State Mastitis Control program reported that the laboratory system is being centralized, but the program remains broadbased and well utilized. They are working closely with the DHIA testing program noting that this is a good opportunity to merge the data gathered in the Mastitis Control program with the somatic cell count and production data of the DHIA program to study the effects on each other. Dr. Jordan reported that the Vermont program is growing, and Dr. Post of Connecticut remarked that their program is in need of more extension and educational assistance than that currently available.

Dr. John Post of the University of Connecticut reported that “Lyme Disease,” first discovered in Lyme, Connecticut, has now spread to 24 states. It is a cause of arthritis and severe skin rashes in young humans and some animals, especially dairy cattle. The spirochete type of organism can be transmitted through the urine and by the bite of insects, especially ticks. Deer and field mice are the main reservoir of the disease. The mastitis significance is the result of most cattle bites occurring on the udder causing a severely swollen and inflamed quarter resembling mastitis but with no infection within the quarter. This has caused the condition to be misdiagnosed as mastitis and treatment with the usual mastitis
infusion products producing no results. However, systemic treatment with tetracycline clears up the condition.

There were no resolutions offered at this time, but the Committee agreed to meet again in February 1987 during the National Mastitis Council meeting in Orlando, Florida. It was also agreed to continue the practice of holding a joint meeting with representatives from the National Mastitis Council, AVMA, and Bovine Practitioners’ Mastitis Committees.
RECENT RESEARCH ON SALMONELLA IN FOOD ANIMAL SPECIES AND POSSIBLE HUMAN HEALTH IMPLICATIONS

Charles S. McCain D.V.M., M.S.
Dept. Veterinary Parasitology, Microbiology & Public Health
Oklahoma State University, Stillwater, Oklahoma

Salmonellosis is one of the most important and widespread of the zoonotic diseases occurring in the developed countries of the world. It is estimated by CDC that it probably represents the largest single communicable disease in the U.S. today. It was first made a reportable disease in the U.S. in 1950 when a total of 1,233 human cases were reported annually and CDC estimates that the reported cases represent only about 1% of the actual cases that occur. If this estimated incidence is reasonably accurate then approximately 4 million people in the U.S. suffer from salmonellosis each year.¹

Foods and products of animal origin continue to serve as the primary vehicle in outbreak investigations of human cases so it is important that we recognize the nature of the disease in our animal populations. It has been estimated that approximately 4 billion domestic animals are present in the U.S. today and that at least 3–5% of these are infected with salmonella. The true incidence of the carrier state in our domestic animal population is impossible to ascertain but we are beginning to recognize the magnitude of the problem. For years, salmonellosis has been considered to be a gastrointestinal disease of man and animals with a septicemia and a transitory intestinal carrier state to follow in a small percentage of those affected. With the emergence of serotype *Dublin* as a new and important pathogen in cattle in this country, we have recognized the added significance of the extraintestinal carrier state and of asymptomatic carriers of salmonella. Following an outbreak of salmonella of serotype *Dublin* in closed dairy herds, clinical disease would often apparently disappear only to reoccur in recovered animals at stress of parturition. Shedding of viable organisms in milk from clinically normal udders of apparently healthy cattle under these conditions is recognized.

Transovarian transmission of serotype *Pullorum* has long been recognized in poultry and the disease has been essentially eliminated from large commercial poultry operations by testing and removal of infected birds along with improved hatchery operations. Recent recognition of serotype *Hadar* in turkey breeder flocks has reestablished the importance of transovarian transmission of this and other salmonella serotypes in poultry.

The U.S.D.A. and the Food Safety and Inspection Service in 1967 initiated benchmark studies to determine the presence of salmonella in chickens processed for human food in Federally inspected plants. In the initial study, salmonella was isolated from 28.6% of the carcasses. In a
followup study in 1979, it was found that 36.9% were positive for salmonella.

At the same time in other laboratories, studies relating to recovery of salmonella from various tissues and organs of food producing animals were in progress. Moo and coworkers in Australia sampled cecal and jejunal lymph nodes from adult cattle, yearling cattle, sheep, lambs, and pigs. Two lymph nodes were collected from each of a total of 180 animals at slaughter. Using appropriate enrichment cultural techniques, salmonella were isolated from 30% of the cattle, 18% of the swine, and from 4% of the sheep. A total of 17 serotypes was identified from the salmonella isolated.

In Georgia, Keteran, et al, isolated salmonella from the mesenteric lymph nodes of 58.2% of 115 sows and 31.5% of 51 slaughter hogs. Fourteen salmonella serotypes were identified from 83 isolates.

Nelson and colleagues reported in 1982 on the prevalence of salmonella in various age groups of market swine. Fecal swabs only were collected from feeder pigs and mesenteric nodes and cecal contents were collected from market swine and cull boars. Based on fecal swabs along only 0.25% (2/800) of the feeder pigs were positive for salmonella. At slaughter it was found that 25.7% (494/1920) market swine and 79% (158/200) cull boars demonstrated a variety of salmonella serotypes in cultures from either the mesenteric nodes or from cecal contents.

A study from Australia indicated a high rate of infection in 100 cattle slaughtered on Tuesday after arriving at the slaughter yards on the previous Friday. Samples collected included heart muscle, rumen contents, liver, spleen, and mesenteric lymph nodes. Salmonella of several serotypes were found in one or more of the samples from 76% of the cattle.

In these most recent studies the experimental design was planned to measure the relationship of age, stress of movement, and stockyard or holding pen contamination of the animals prior to slaughter. The authors tended to indicate that the laboratory recovery of salmonella was an indication of recent infection in the holding pens or resulted from the stress of hauling the animals to market. Little consideration was given to the concept that the infected animals might have been recovered asymptomatic carriers. Isolation of numerous serotypes from a group of animals could suggest that the infection was not from a point source.

Following the usual oral introduction from contaminated food or water, salmonella as an intracellular parasite has the ability to live within the host cells for long periods of time unaffected by phagocytic cells and the traditional circulating antibody that assists in destroying most invading bacterial pathogens.

With this concept in mind, studies have been conducted in this authors laboratory to determine the extraintestinal carrier rate in apparently healthy cattle, swine, and horses. With permission of the Inspector in Charge at inspected slaughter establishments, samples of mesenteric
lymph nodes were collected on the kill floor following evisceration of animals that passed antemortem and postmortem inspection procedures.

Several lymph nodes were collected from each animal and placed in sterile plastic bags and frozen. All samples were maintained in a frozen state until ready for processing and culture. After thawing under refrigeration, the nodes were trimmed of fat and excess tissue with sterile instruments. The surface of each node was sterilized by flame prior to placing 10 grams of tissue from each animal in a sterile plastic bag. The tissue was then processed in a Colworth “stomacher” to allow cellular disruption and liberation of the intracellular salmonella if present.

Utilizing standard techniques of incubation in enrichment cultures and selective plating media, salmonella like colonies were picked for further cultural and biochemical identification.

By the use of this technique, we have identified salmonella of a variety of serotypes from 16.16% (16/99) of cattle, 51.45% (53/102) of swine and from 71.42% (50/70) of horses. All were from apparently healthy animals, free of any visible disease that were being slaughtered for human consumption.

Since lymphoid tissue similar to that of the mesenteric nodes is present in most of the major carcass cuts it follows that salmonella could be present in variable numbers in most commercial cuts of meat and thus serve as potential source of infection for the consumer if not adequately prepared and handled prior to consumption.

In 1981, Smeltzer and Thomas in Australia reported the results of a study conducted to determine the potential for transfer of salmonella to meat and edible offal by knives used in the carcass dressing and inspection procedures. When each workers knife was culturally sampled 15 times on each of 10 different occasions, salmonella was isolated from the knives of one worker on 21/150 occasions for a rate of 14%. Mean colony counts per blade ranged from 1.2 to greater than 366 colonies. When two other inspectors knives were sampled for a total of 300 samples, no salmonella was isolated. This would indicate to me that while the inspectors knives could be a possible source of contamination of carcasses, the usual sanitary procedures used in knife decontamination should prevent this from being a source of carcass contamination with a significant number of salmonella.

The growing trend of meat processing whereby ground beef is prepared in bulk quantities in processing plants prior to shipping to ultimate consumers in the fast food industry and school lunch programs provides an opportunity for large scale contamination with a low number of viable salmonella that can then increase to possible pathogenic numbers prior to final consumption. The use of mechanical deboning equipment also potentially plays a role in allowing an increasing number of viable organisms in the final product.

It is apparent that with the potential of contamination of foods of animal origin that it is essential that these foods must be stored, cooked and served
in an appropriate manner if we are to reduce the potential for widespread infection with salmonella.

REFERENCES
The Food Animal Hygiene Committee was called to order by Chairman, Dr. Alfred W. Bailey at 1:30 p.m., October 20, 1986. Eighteen (18) persons were in attendance.

Mr. Jacek Sivinski of CH2M-Hill, Albuquerque, New Mexico presented an overview of beneficial uses of irradiation of foodstuffs, Radiation Technology and Prevention of Food-Borne Illnesses. The presentation included a forty (40) year summary of radiation which is an outgrowth of atoms for peace instigated by President Eisenhower.

Mr. Sivinski provided the committee with several monographs for references relating to the current status of radiation uses on meat and poultry products. Irradiation of meat products now seems economically feasible in the food processing industry.

Dr. Pat Smith, California Department of Agriculture presented an epidemiological overview of *Listeria species* in milk and cheese products in California. The problem of *Listeria sp.* contamination in milk and cheese products appeared to be associated with the ubiquitous nature of the organism.

Dr. C. S. McCain, Oklahoma State University reviewed contemporary problems in the meat and poultry industry. The complete text of his presentation will be presented for publication in this sessions proceedings.

The committee’s long range plans are to continue to serve as a forum for discussion of emerging and long term trends in food animal hygiene. We feel that the function of the committee would be enhanced by making a concerted effort to increase our membership among representatives of the meat and poultry industry.
On May 12, 1966, the Ministry of Agricultural and Livestock Development of Panamá (MIDA) by authority of Decree No. 121, divided the entire Darien Province (the area adjacent to Colombia) into 2 zones—Control and Inspection. This law was promulgated because of concern over the possibility of the entrance of Foot and Mouth disease (FMD) from Colombia. The decree restricted livestock development in the Comarca de San Blas (San Blas Reserve) and the Darien province. In 1967, the Regional International Organization for Animal and Plant Health (OIRSA) made up of Mexico, the Central American countries and Panama was authorized to establish various posts within the inspection zone and Puerto Obaldia, Comarca de San Blas to enforce the provisions of the decree.

An agreement between the U.S. Department of Agriculture (USDA) and MIDA, signed May 26, 1972, and later amended by an exchange of diplomatic notes and letters in 1973 and 1974, led to the establishment of the Panama-U.S. Commission for Prevention of Foot and Mouth Disease and Rinderpest (COPFA). These actions provided COPFA with funds and a legal basis to develop and administer an effective vesicular disease prevention and surveillance program and to provide an emergency animal disease control and eradication plan if an exotic disease entered Panama. The long range goal of this organization was to minimize the danger of the entrance of FMD from Colombia during construction and after the completion of the Pan American highway. In June 1974, COPFA was established with Dr. Arcadio Carrizo as Director and Dr. Ted Rea as Co-Director.

They proceeded with the development of the policy, regulations, goals, and structure of the Commission. This technical executive committee (director and co-director) is responsible to the Commission composed of the Minister of MIDA and the Secretary of the USDA or such official representatives as each may designate.

COPFA has experienced many changes since its inception 12 years ago; however, the basic structure has remained intact and effective. Panama has remained free of FMD. In order to maintain this free status, 3 primary objectives have been followed: prevention of foreign animal disease (FAD), primarily FMD and rinderpest; surveillance to detect the presence of FAD; and preparation to eradicate an FAD outbreak should it occur in Panama. COPFA has a total staff of 86 people working to attain these goals. These are 10 MIDA employees, 1 OIRSA employee, 4 USDA employees (1 foreign

* Subtitle: THE PREVENTION OF FOOT-AND-MOUTH DISEASE IN THE DARIEN GAP, PANAMA

** USDA, APHIS VS
U.S. EMBASSY PANAMA
APO MIAMI 34002

236
LOOKING FOR THE SALT WATER PIG

service national) and 71 COPFA employees. COPFA began 1975 with 5 paid employees; reached a high of 87 employees in 1981; and by 1985 was reduced to 71 employees; the same number as currently employed.

One important addition to COPFA has been the Laboratory for Vesicular Disease Diagnosis (LADIVES). LADIVES began operations in late 1982 after 6 years of planning and construction at a cost of approximately $600,000 (80% U.S. funds—20% MIDA—OIRSA) and presently operates with total annual expenses of approximately $158,000 (COPFA funds $75,000—MIDA/OIRSA funds $83,000). The staff of 3 professionals and 7 support personnel provides rapid vesicular disease diagnosis for all of the 6 Central American countries and Panama and offers training in diagnostic techniques to interested individuals and cooperating organizations. During 1985, LADIVES ran tests on 292 samples representing 220 vesicular investigations. This was down from 1984 when 375 samples from 288 investigations were received and processed. The first 6 months of 1986 presented 127 samples from 101 field investigations. All of the samples tested were negative for FMD. In an average year about 50% of the investigations are positive for VS-New Jersey; 9–10% positive for VS-Indiana; and 38–40% are negative for any vesicular disease.

COPFA utilizes the full time service of an MIDA veterinarian in the interior of Panama (Liaison zone) to coordinate program activities with other MIDA professionals and to investigate suspected vesicular disease outbreaks. With the exception of the Central office staff, all other COPFA employees work primarily in the San Blas Reserve and the Darien Province. COPFA field veterinarians, inspectors, and support personnel regularly provide surveillance over a livestock population that averaged in 1985; Comarca de San Blas—1100 hogs; Inspection Zone—1400 hogs; Control zone—4000 hogs, 17,100 cattle. While the raising, feeding, and processing of hogs on a small scale is permitted in the Comarca de San Blas and in both zones; cattle production is permitted only in the control zone of the Darien.

The Darien province is relatively free of the severe infectious and contagious diseases of livestock usually encountered in the tropics. Except for external and internal parasites, screwworm myiasis, and an occasional outbreak of vesicular stomatitis, this area presents a healthy environment for food producing animals. This situation has produced pressure on the Panamanian government to open up the Control zone to more livestock farms and there is a proposal under the study at this time by an interagency committee. The Pan American highway was finally opened in 1985 for all weather vehicular travel all the way to Yaviza, Darien—to within 35 miles of the Colombian border. This has resulted in more vehicular traffic, more commercial activity, more agricultural land development, and increased population pressures. With this changing situation the area has become more vulnerable and a strong animal health surveillance and control program has become more important. COPFA is in place and is
working to meet this new challenge. As outlined before, the Darien province is divided into 2 zones—the control zone with a central office at Santa Fe and inspection posts located at Cañazas, Santa Fe, Cucunati, Meteti, Rio Iglesias, La Palma, Seteganti, Garachine, Sambu, and Jaque. The inspection zone is headquartered at Yaviza (at the end of the Pan-american highway) on the Tuira River and has posts at Yaviza, El Real, Tupiza, Paya, Boca de Cupe, and Manene. All posts are equipped with radios that can communicate with each other and the central office. Each post also has the necessary items for making inspection visits; such as, 4 wheel drive vehicle, large boat or dugout canoe (piragua) with outboard motor, motorcycle, and/or a saddle horse or mule.

Inspection procedures in the Comarca de San Blas are supervised by the technical operations veterinarians out of the Panama central office. About 300 islands and a long narrow strip of land extend along the Caribbean coast of Panama from the Colon province to the Colombian border (see map). Approximately 40 of the islands in this coastal chain are inhabited by the Kuna Indians. The Kuna live in traditional thatched roof houses clustered together on these small off-shore islands and maintain small farms on the mainland coast. On these small, crowded islands, the Kuna maintain and raise pigs for local consumption. Since space is limited, many of the pigpens extend out over the water on wooden piers and some small pens even extend from the beach area out into the ocean. It is here the "salt-water pig" may be found. What other term could possibly be used for a pig that continually cools itself in the ocean?

In order to carry out its mission, the program activities of COPFA can be summarized as:

1. Primarily FAD prevention;
2. Inspection of all livestock and ranches in the designated areas;
3. Maintenance of proper records of all livestock in inspected areas to include—census, identification, births, deaths, slaughter, and movement;
4. Field investigation of all suspected vesicular or other exotic animal diseases in inspected zones;
5. Control movement of livestock and animal products into and out of inspected zones;
6. Inspection of coastal and overland traffic at border ports and stations of inspected zones;
7. Providing public information programs and materials on FAD and animal disease prevention;
8. Providing laboratory diagnosis of suspected vesicular disease;
9. Preparation to rapidly control and eradicate FMD or other FAD outbreaks;
LOOKING FOR THE SALT WATER PIG

10. Providing training for COPFA employees and cooperating organizations;

11. Cooperation with MIDA on animal health and quarantine programs; and

12. Cooperation with national and international organizations in animal disease prevention programs.

Although inflation has decreased the purchasing power of the COPFA budget by approximately 62% since 1974, the total amount has remained constant at $555,555.55 (90% U.S. funds—10% Panama). In general, basic program activities have been maintained; however, some program cutbacks have been necessary. These include:

1. Eliminating 4 veterinary positions located outside the Darien zones;

2. Removing 2 large boats used in coastal surveillance;

3. Replacing COPFA salaried employees with MIDA salaried employees;

4. Increasing inspection time interval in the field; and

5. Reducing the COPFA work force from a high of 87 in 1981 to 71 employees at the end of 1985.

Future program needs are:

1. Increased funding of 10% per year to compensate for increasing costs;

2. Construction or improvement of control posts at several Darien locations;

3. Increased public information activities;

4. Increased animal disease surveillance; and

5. Increased contact with cooperating organizations.
EMERGENCY PROGRAMS PROGRESS REPORT
Dr. Arthur E. Hall

Foreign Animal Disease Investigations

During fiscal year (FY) 1986 (October 1, 1985, through September 30, 1986), 165 foreign animal disease (FAD) diagnostic investigations were conducted in the United States and Puerto Rico, including 115 investigations of suspected vesicular conditions. Additional secondary investigations because of avian influenza numbered over 170 and exotic Newcastle disease numbered 228.

Vesicular Stomatitis

The first FY 1986 isolation of vesicular stomatitis (New Jersey) virus was made at the Foreign Animal Disease Diagnostic Laboratory (FADDL) from a Montezuma County, Colorado, bovine tissue submission collected July 18, 1986.

1986 Vesicular Stomatitis Positive Laboratory Results:

<table>
<thead>
<tr>
<th>State</th>
<th>Virus* Positive*</th>
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<tbody>
<tr>
<td></td>
<td>Isolation</td>
</tr>
<tr>
<td>Arizona</td>
<td>0</td>
</tr>
<tr>
<td>Colorado</td>
<td>6</td>
</tr>
<tr>
<td>New Mexico</td>
<td>0</td>
</tr>
<tr>
<td>Utah</td>
<td>2</td>
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*All New Jersey

Virus isolation during FY 1986 was limited to eight premises — six in Colorado and two in Utah.

Hog Cholera/African Swine Fever (HC/ASF)

Fifteen suspect HC/ASF investigations were made in response to either suspicious clinical disease or positive slaughterhouse surveillance serums. All investigations were HC/ASF negative.

Annually, about 20,000 swine blood samples are tested from pigs slaughtered in Massachusetts, New Hampshire, New Jersey, Texas and Puerto Rico at the National Veterinary Services Laboratories (NVSL), Ames, Iowa. This testing serves as an adjunct to our primary defenses against an outbreak of African swine fever or hog cholera.

This past summer researchers working on Acquired Immune Deficiency Syndrome in Belle Glade, Florida, excited the news media when they sampled sick swine in the area. The researchers reported the swine had evidence of African swine fever. As soon as the Animal and Plant Health Inspection Service became aware of these reports, the pigs were quarantined to their premises under State authority, as is done in the case of any foreign animal disease investigation. In this case, all adult hogs on three farms were tested and the samples were sent to FADDL on Plum
Island, New York. All 126 serum samples, 43 tonsil biopsies, and tissue specimens were subjected to an exhaustive series of tests — all with negative results. Specimens carried to Pirbright, England, by the researchers were also negative.

Four Veterinary Services field veterinarians went to Mexico to gain firsthand experience with hog cholera diagnosis. The Emergency Field Operations Staff recognizes the need to maintain a cadre of experienced hog cholera diagnosticians in light of the threat to the United States swine industry from hog cholera because of its worldwide distribution.

**Viscerotropic Velogenic Newcastle Disease**

On November 13, 1985, virus was isolated from a yellow nape in the State of Washington. A California dealer's premises that was the source of the birds was also depopulated because of detection of the virus.

On March 31, 1986, viscerotropic velogenic Newcastle disease (VVND) virus was isolated from a yellow nape parrot located at Belvidere, New Jersey. The infected bird had been purchased March 15, 1986, from a Cinnaminson, New Jersey, pet bird dealer. The dealer's 2,414 birds were depopulated on April 2, 1986, because of the disease.

As a result, over 300 tracebacks from the Cinnaminson dealer were conducted in 12 States. These disclosed an additional infected dealer's premises at Toms River, New Jersey, that needed depopulation. Forty-nine negative tracebacks resulted from the Toms River case. In addition to the other cases, there were three additional confirmations of VVND in yellow napes in California during March and April.

The origin of the infection in all outbreaks was never determined; however, circumstantial evidence and the yellow nape parrots suggest smuggled birds from Mexico were responsible. Two VVND infected smuggled cockatoos were intercepted at the St. Thomas, U.S. Virgin Islands airport prior to exposure to United States birds. Both were seized and quickly died of the disease. It should be noted that no VVND was identified in commercial poultry and that once again the disease was successfully eliminated from pet bird trade channels.

**Avian Influenza**

On January 8, 1986, avian influenza (AI) virus (H5N2) was isolated from a chicken flock in Snyder County, Pennsylvania. During the next 12 weeks, 13 additional Pennsylvania flocks were found infected, as were four commercial operations in New Jersey, one in Massachusetts, and one in New York. These infections apparently resulted from either direct or indirect contact with live poultry markets in New York City and New Jersey. On February 1, H5N2 virus was first isolated from a live bird market in New York City. By early March, the virus had been isolated from 26 live bird markets in New York City, 12 in New Jersey, and 3 in New England. These isolations came in the wake of a survey that was
initiated by Veterinary Services (VS) in the Northeastern States on February 18, and completed on March 5, 1986.

Objectives of the survey were to: (1) Determine the extent of the live bird marketing system in the VS Northern Region, with emphasis on the New York City metropolitan area, (2) determine the value of live bird marketing as an AI surveillance tool, and (3) determine how the live bird industry may be operated to minimize the risk of maintaining and disseminating avian influenza virus.

It was learned that poultry, which includes ducks, turkeys, guinea fowl, chickens, and geese, change ownership 2 to 5 times between the first buyer and the consumer, when these birds are destined for live bird markets in the Northeastern States. Components of the live bird marketing system include: producers — commercial integrators, backyard hobbyists, duck farms, etc.; auction markets and concentration points, dealers, wholesalers in New York and New Jersey, and retailers.

Poultry crates, trucks, and other equipment were moving avian influenza virus back and forth between producers and retailers until control procedures were initiated with industry cooperation in early February. The procedures were designed to ensure that the cycle of infection that was moving H5N2 virus through the marketing system (i.e., from producer to market and vice versa) was broken. Actions taken included the cleaning and disinfecting of crates, trucks, and other equipment, and the depopulation of infected poultry.

Both sodium hypochlorite solutions and One-Stroke Environ were used as disinfectants. One-Stroke was considered superior to sodium hypochlorite for the situations encountered and was used when possible.

New Jersey, Rhode Island, and Connecticut eliminated H5N2 virus from their few contaminated markets by depopulation, followed by cleaning and disinfection.

Initially 26 of 41 New York City markets were found to be contaminated with H5N2 virus. Most market operators were reluctant to remain free of birds for longer than 24 hours at a time. By following a regimen of 24-hour depopulations, followed by cleaning and disinfection (C&D), all markets eventually were cleaned up. Then during the week of June 23, all markets were again sampled. Four were again found to be contaminated with H5N2 virus, and the regimen of depopulation with C&D was repeated. The New York metropolitan markets are scheduled for resampling this fall.

A survey of live bird marketing in the VS Southeastern Region was completed April 3, 1986, and extensive live bird marketing was found in Miami, Florida. Sales of live birds in the Miami area are made from "botanicas," rather than traditional live bird markets. Botanicas sell voodoo paraphernalia, including all varieties of birds for sacrificial purposes. They purchase their chickens, guinea fowl, turkeys, quail, pheasants, pigeons, and exotic birds from dealers, as well as from each other. An
estimated 50 botanicas maintain birds on their premises. Birds are also held on farms, some of which are operated by botanica owners. Poultry dealers purchase chickens directly from commercial producers or, more often, from other dealers in Georgia and other Southeastern States. Poultry sampled at 8 out of a total of 18 dealers and botanicas inspected in the Miami area were found to be contaminated with H5N2 virus.

Similar poultry marketing surveys conducted in the VS Central and Western Regions did not disclose the presence of H5N2 AI virus.

None of the H5N2 viruses isolated during 1986 have met the criteria established for highly pathogenic avian influenza virus. Indeed there have been no isolations of highly pathogenic H5N2 virus in the United States since April 1, 1984. All isolates in the VS Northern Region and Florida this year have been characterized as nonpathogenic or low pathogenic by NVSL. Veterinary Services involvement in the 1986 H5N2 incidents has been strictly limited to the provision of diagnostic, epidemiological, and technical assistance to the affected States. Affected States and industries have seen to the quarantining, depopulation, and C&D for the outbreaks.

H5N2 avian influenza virus was isolated April 2, 1986, from an Oregon premises with 110,000 quail, 7,000 pheasants, 9,000 chickens, and a small number of ducks and pigeons. Genetic mapping at St. Jude's Children's Research Hospital indicated that the viral strain was not antigenically related to the PA 83 virus. The chickens at the facility, although in contact with other poultry, did not become infected. The Oregon flock which consists of slaughter poultry was not depopulated; however, three Washington poultry operations exposed to the Oregon flock were depopulated by State officials.

During FY 1986, a National Nematodirus battus survey of sheep flocks was conducted. Thirty three thousand six hundred and one fecal specimens were examined at NVSL from 49 States, as well as the U.S. Virgin Islands and Puerto Rico. Five States were detected with affected sheep on 33 premises.

Two FAD diagnostic training courses were held for 36 veterinarians. This training is considered to be the best of its kind in the world and involves 1 week at both NVSL and FADDL followed by two days in Hyattsville in the Emergency Programs Information Center. At FADDL, the trainee usually observes and follows the progress of 14 to 16 FAD's in animals. Approximately 275 trained diagnosticians are in the continental United States.

A Military Support Course was held in the Emergency Programs Information Center during April 1–4, 1986. Training was provided to 17 military participants. In addition, 40 diagnosticians were provided up-to-date training at Lincoln, Nebraska, in February; and 15 diagnosticians received training for Foreign Animal Diseases in Wildlife at Athens, Georgia, in May.
A new course was offered this year at Plum Island to 18 teachers of veterinary students. The course increases their knowledge of foreign animal diseases so that they can provide better instruction in the subject. Another course will be given in November 1986.

During the year, the Recorded Emergency Animal Disease Information (READI) system was extensively revised to eventually permit data entry at both Veterinary Services Regional and Area Offices. The changes will permit more rapid and convenient management of data during routine investigations of suspected foreign animal diseases, as well as during a foreign animal disease task force operation.

The four Regional Emergency Animal Disease Eradication Organizations (READEO's) are fully staffed and maintained to respond rapidly to outbreaks of emergency diseases.

Veterinary Services has continued cooperative agreements with the Southeastern Cooperative Wildlife Disease Study in Athens, Georgia, and the University of Wisconsin. These projects are concerned with the role of wildlife in any outbreaks of foreign animal diseases and for reference in the identification of VVND.

The Data Bank now has about 60,000 articles on foreign animal diseases for 47 diseases, entomological items, and other subjects.

October 1986
REPORT OF THE COMMITTEE ON
FOREIGN ANIMAL DISEASES

Chairman: Dr. J. L. Hyde, College Park, MD
Vice Chairman: Dr. W. W. Buisch, Lanham, MD

Dr. J. J. Callis, NY; Dr. H. Campos, DC; Dr. C. A. Carson, MO; Mr. A. A. Chadwick, DE; Dr. G. S. Colgrove, IA; Mr. R. Combs, NV; Dr. A. H. Dardiri, NY; Mr. J. B. Finley, TX; Dr. J. C. Franson, WI; Dr. W. C. H. Glaze, TX; Dr. C. M. Groocock, NY; Mr. R. Hack, DE; Dr. F. M. Hamdy, DC; Dr. P. R. Henry, CO; Dr. B. R. Heron, CA; Dr. W. P. Heuschele, CA; Dr. J. A. House, NY; Mr. R. D. Jones, SD; Dr. F. M. Jones, FL; Dr. D. D. King, MD; Dr. K. L. Kuttler, ID; Dr. L. L. Logan, NY; Dr. D. W. Luchsinger, NY; Dr. E. H. McCauley, MT; Dr. H. A. McDaniel, MD; Dr. P. D. McKercher, NY; Dr. N. Meyer, VA; Dr. R. B. Moody, MO; Dr. G. C. Poppensiek, NY; Dr. K. R. Preston, TX; Dr. I. R. Reid, Canada; Dr. S. L. Reynolds, TX; Dr. M. D. Salman, CO; Dr. E. C. Sharman, MD; Dr. A. W. Smith, OR; Dr. L. G. Sullivan, MI; Dr. P. H. Timm, CA; Dr. R. A. Todorovic, IN; Dr. T. E. Walton, CO; Dr. S. T. Wilson, Jr., MD; Dr. J. H. Wyss, MD; Dr. R. J. Yedloutschnig, NY.

Notes From the Exotic Animal World

Dr. Werner P. Heuschele, San Diego Zoo discussed Tuberculosis in the Royal Arabian Oryx. He noted that in primates, the eyelid is often used as the preferred tuberculin test site. In the Royal Arabian Oryx, four reacted at the cervical test site while none reacted in the eyelid. Dr. Heuschele identified the need for more diagnostic and immunological work in Malignant Catarrhal Fever (MCF). Currently work on MCF is continuing at the University of Florida, University of California and the San Diego Zoo. A neonatal diarrhea in Springbok, very similar to border disease was also discussed. The need for importing exotic ruminants, especially those that are considered endangered was discussed by the committee at some length. While it was recognized that the preservation of these species of animals is very important, it was also emphasized that procedures for importation must be sufficient to prevent the entry of diseases of concern.

Malignant Catarrhal Fever

Dr. A. H. Dardiri discussed the Lyophilization and Virulence Testing of Malignant Catarrhal Fever Virus.

Pathogenic malignant catarrhal fever virus was isolated from white blood cells of cattle in calf thyroid cell cultures. Virus from these cell cultures was not infective if stored for more than 30 days at -70°C; lyophilization of low passage virus was the method of choice for preservation of pathogenic virus. This material was viable up to 6 years.

Virus was attenuated by serial passage in cell culture, its pathogenicity could only be maintained by passage in bovines. This passage caused
FOREIGN ANIMAL DISEASES

pathogenicity changes with enteric signs predominating without head and eye clinical signs.

Swine Repopulation — Haiti

A video tape covering the swine repopulation program in Haiti was presented by the Inter-American Institute for Cooperation on Agriculture (IICA) Dr. Hector Campos Lopez, IICA's Director of Animal Health, indicated that following total depopulation of Haiti's swine herd because of African Swine Fever (ASF), initial repopulation efforts have been very successful. Using funds provided by the U.S. Agency for International Development (AID) a Haitian National herd of approximately 60,000 head has now been developed.

Heartwater and the Tropical Bont Tick in the Caribbean

Dr. Roger Drummond briefed the committee on the current status of the presence and spread of the tropical bont tick, *Amblyomma Variegatum*, heartwater (cowaedriosis) and acute bovine dermatophilosis in the Caribbean. He reported on the development of a feasibility proposal to manage this tick and its associated diseases. A draft of a feasibility proposal has been written and is in the process of being revised. This proposal has been reviewed by a variety of scientists representing a number of national and international organizations. It classifies islands in the Caribbean according to the present extent of infestation of *A. variegatum* and presents appropriate strategies to manage this tick on islands in the different categories. The proposal will be completed about the first of the year and will be the subject of discussions at a meeting to be held in the Caribbean in March 1987.

Foreign Animal Disease Preparedness in Canada

Dr. Ross Reid discussed the organization training and support of Canada's regional alert teams formed to quickly respond to foreign animal disease emergencies. A unique feature is their association with Emergency Preparedness Canada, a federal organization charged with assisting Canadian government departments with the planning and delivery of emergency response programs. The majority of their Foreign Animal Disease investigations have been Newcastle Disease investigations in chicken and pigeon flocks. Only Lentogenic virus was found. Also, low level CF positive titers to anaplasmosis were found upon post entry testing of U.S. cattle imported under the Dairy Herd Reduction program.

Sero-surveillance sampling for bluetongue, porcine brucellosis and pseudorabies have been conducted. Bluetongue reactors can only be found in British Columbia's Okanagan Valley. All porcine brucellosis and pseudorabies tests continue to be negative.

Foot and Mouth Disease — Mexico

Dr. John Mason, Technical Co-director of the Mexico-U.S. Commission
REPORT OF THE COMMITTEE

for the Prevention of Foot and Mouth Disease reviewed the eradication of Foot and Mouth Disease (FMD) from Mexico — 1947 to 1954 and the prevention of FMD in Mexico since that time. He also advised the committee that the "Proceedings of an International Conference on Vesicular Stomatitis" held in Mexico City in September 1984 are now available and can be obtained free of charge by writing to Dr. John Mason, Mexico City/Department of State, Washington, D.C. 20520.

Emergency Programs in the United States

Dr. Arthur E. Hall reported on activities in Emergency Programs.

During fiscal year 1986, 165 foreign animal disease (FAD) investigations were conducted in the United States and Puerto Rico. Secondary investigations due to Avian Influenza and Exotic Newcastle Disease numbered 398.

Evidence of Vesicular Stomatitis infection (New Jersey) was found in four western states, Arizona, Colorado, New Mexico and Utah. Investigations into fifteen suspect Hog Cholera and African Swine Fever outbreaks proved negative. Routine tests of 20,000 slaughter house swine sera from five states were completed.

Viserotropic Velogenic Newcastle Disease virus was isolated from yellow nape parrots in the state of Washington and in New Jersey. Over 300 tracebacks from the New Jersey identification were made in 12 states. The source of the infection was traced to a California dealer. There were three additional confirmations of VVND in California. Circumstantial evidence suggested that smuggled birds from Mexico were the source.

Two VVND smuggled cockatoos were intercepted in the U.S. Virgin Islands. No VVND was identified in commercial poultry in the U.S.

Avian Influenza type H5N2 occurred in Pennsylvania, New Jersey, Massachusetts and New York. Veterinary Services (VS) initiated a survey in the northeastern states to assess the relationship to the live bird marketing system and control of AI. As a result, additional virus isolations were made from New Jersey and New England. Markets contaminated with AI in New York City were reduced from 26 to 4. The latter were depopulated in June. Resampling is planned this fall. Similar marketing surveys in the Veterinary Services southeastern region detected contaminated dealer premises in the Miami area. Central and western regions were free. H5N2 virus was isolated from an Oregon premises containing quail, pheasants and other fowls. None of the viruses isolated during 1986 have met the criteria established for highly pathogenic avian influenza virus. There have been no isolations of highly pathogenic H5N2 virus in the United States since April 1, 1984.

A National Nematodirus Battus survey of sheep flocks was conducted. Thirty three thousand, six hundred samples were examined from 49
FOREIGN ANIMAL DISEASES

states, U.S. Virgin Islands and Puerto Rico. 33 premises in five states were infected.

Hog Cholera training for four VS staff was conducted in Mexico. Two FAO training courses were held at NVSL and FADDL. Courses were also held for military personnel interested in Foreign Animal Diseases as well as diagnosticians interested in the diagnosis of Foreign Animal Diseases in Wildlife.

The Recorded Emergency Animal Disease Information (READI) System was expanded to allow access by all VS Regional and Area offices. The data bank has about 60,000 articles on FAD.

Prospects for Integrated Control of Ticks and Tick-Borne Diseases of Cattle in Africa

Dr. C. M. Groocock, reported that ticks and the tick-borne diseases, theileriasis, heartwater, babesiosis, and anaplasmosis are major constraints to the development of the livestock industry in Africa. Traditional methods of control using acaricide application and quarantine are not sustainable on a long term basis for political, sociological and financial reasons. To control East Coast Fever (theileriasis) cattle are dipped and sprayed twice a week. Such methods result in residues in pasture and food, induce chemical resistance in tick populations, and create epidemic instability to tick-borne disease. Repeated cycles of control breakdown cause disastrous losses in Africa.

Scientists at Muguga have shown that by the use of integrated control procedures comprising of; 1) reduced conventional acaricide application; 2) acaricidal eartags; 3) exclusion of wildlife from paddocks; 4) immunization against tick-borne disease and 5) induction of host resistance to ticks, a high degree of stability can be achieved and improved breeds of cattle can be highly productive in areas of Africa, where lethal challenge of tick-borne disease had previously excluded them. These new approaches to control tick and tick-borne disease will help food production in Africa and diminish the threat of tick-borne disease from Africa.

Screwworm Update

Dr. James E. Novy reported that the Mexico-United States Commission for the eradication of screwworms Cochliomyia hominivorax, (Coquerel) has established an effective sterile fly barrier at the Isthmus of Tehuantepec in Mexico in order to prevent the reinfestation of the freed areas of that country as well as the United States. 140,790,610 hectares (72 percent of the land surface of Mexico) in twenty-two states in Mexico have been declared officially free of the screwworm, an obligate parasite of all warm-blooded animals. An additional 31,191,090 hectares (16 percent, of Mexico’s land surface in four states have gone at least “six months without a screwworm infestation,” the requirement to declare a state free. Only 24,007,100 hectares (12 percent) in five states remain infested.
REPORT OF THE COMMITTEE

From October 1985 to September 1986 there were 4,014 samples of larvae from wounds in animals submitted for identification. 1,566 of these samples were positively identified as screwworms or approximately 39% of the total. Only two positive cases were reported from north of the Isthmus of Tehuantepec. These were in the state of San Luis Potosi in November, 1985, and were the result of the movement of infested animals from southeast Mexico.

In order to prevent reinfection of freed areas by the movement of infested animals from infested areas, inspection and quarantine stations have operated since January 1985, on the three highways which cross the Isthmus of Tehuantepec. Inspection and quarantine activities are also carried out on the two railroads which cross the Isthmus. From October 1985 to September 1986 there were 335,658 animals inspected and 165 were quarantined when they were suspected of being infested with screwworms.

Sterile screwworm flies are produced at a plant located near Tuxtla Gutierrez, Chiapas, Mexico. From October 1985 to September 1986 the production level has averaged approximately 240 million per week. Sterile flies were dispersed over the Isthmus of Tehuantepec from six different bases during the year. On April 2, 1986, the Agreement under which the Mexico-United States Commission was established was amended to permit the extension of the program to the rest of Mexico and from Central America and Panama. On May 19, 1986, the program was extended into the Yucatan Peninsula of Mexico. There has been a reduction of more than 80 percent in reported cases of screwworms from that area.

On June 19, 1986, an Agreement was signed between the United States Department of Agriculture and the Ministry of Agriculture, Livestock and Food of Guatemala. The Agreement makes it possible for USDA to conduct a field test of a new screwworm fly strain in Guatemala. A site was selected on the Pacific Coast of that country and a test began in September, 1986. The strain being tested was developed by the Agricultural Research Service, USDA, from material collected near Chetumal, Quintana Roo, Mexico, and has been named "Chetumal—85."

It is estimated that expansion of the screwworm program into Central America will require at least five years. The ultimate goal is to eradicate screwworms from most of Panama and establish a sterile fly barrier in Panama near the Panama-Colombia border. In order to accomplish this objective a new plant to produce sterile flies will be constructed in Panama. Subject to funding, the estimated completion date is July 1989. Currently, agreements between the Mexico-United States Commission and the governments of Guatemala and Belize are being discussed in order to begin eradication of screwworms from those countries during 1987.

Zoological Animals

Dr. Victor Nettles reported on the need for a model state regulation for
control of zoological animals. APHIS enlisted the Southeastern Cooperative Wildlife Disease Study (SCWDS) University of Georgia to evaluate trade in zoological animals. They found thousands of animals representing hundreds of species were marketed and that existing regulations were inadequate and fragmented. A draft copy of a model state regulation has been prepared whose contents deal with intent, definition of affected animals, jurisdiction, regulatory boards, permits and licenses, health certificate, and animal welfare.

Representatives of the FAD committee were asked to review the draft regulations and report back their comments within twelve weeks.

University of Florida Activities

Dr. E. P. J. Gibbs, Jr., University of Florida discussed several of their long term research projects. Recognizing that some ticks may survive 12 years, and recognizing that the Ornithodorus tick species may serve as vectors to African Swine Fever, he emphasized their interest in Ornithodorus turicata known to exist in Florida and the western part of the United States, and in Ornithodorus puertoricensis, known to exist in the Caribbean, Central America, Panama, and South America. Relative to their work with the disease of bluetongue, they are emphasizing: 1) the identification of virus serotypes 2) the identification of arthropod vectors 3) the recognition of their economic importance 4) the need for improved import-export policies. Dr. Gibbs also discussed briefly some of their work with Eastern Equine Encephalitis as well as pseudorabies and trichinosis in feral swine.

“Nematodirus battus—Recent Information—Including Epidemiology and Anthelmintic Efficacy Data” G. L. Zimmerman, E. P. Hoberg, L. G. Rickard, and J. K. Erno

This information was presented to the committee by Dr. G. L. Zimmerman.

Epizootiological studies at the Oregon State University College of Veterinary Medicine using tracer lambs have shown that the transmission patterns of Nematodirus battus include all seasons of the year. Demonstration that sheep can become infected with N. battus during extended periods of below freezing air temperature is significant. It is also important that N. battus has been diagnosed from sheep in Eastern Oregon, a high desert area. Llamas from two separate areas have been found to be passing N. battus eggs. Combined survey data (USDA/APHIS/NVSL and Oregon State University) show N. battus to be present in Oregon (24 premises), Washington (8 premises), Vermont (5 premises), New York (5 premises) and Maryland (1 animal imported from Washington). In a survey involving over 33,000 fecal samples, 140 (0.4%) were positive for this parasite. All data and information suggest that N. battus is of limited distribution and recent introduction into the United States. Although an-
thelmintic efficacy trials demonstrate significant efficacy of fenbendazole and ivermectin in removing *N. battus* from individual sheep, complete epizootiological investigations necessary for developing programs to control *N. battus* in the sheep population/environment at large have not been conducted. Such investigations should be conducted and control programs should be developed before populations of *N. battus* develop to disease causing levels.

**Foot and Mouth Disease Prevention in Panama and Colombia Along the Proposed Route of the Pan American Highway**

Dr. Floyd M. Jones, Acting Regional Veterinary Representative for Panama, Central America and Colombia presented a report on the current status of the Foot and Mouth Disease prevention program in Panama and the Foot and Mouth Disease eradication program in Colombia. These programs between USDA and the countries involved were designed to prevent the spread of FMD from Colombia into Panama, particularly if (and/or when) the Pan American highway connecting Panama and Colombia is completed.

In addition a video tape, outlining FMD vaccination trials in Colombia was presented.

**Transmitting Viruses Through the Transfer of Bovine Embryos**

Drs. Callis, Mebus, and Stringfellow reported on experiments designed to assess the danger of transmitting viruses through the transfer of bovine embryos.

They concluded that embryo transfer might be a suitable mechanism for domestic and international movement of germ plasm without great risk of also transferring infectious agents. Foot and Mouth Disease virus and Bluetongue virus could be removed by enzyme washing from embryos with the zona pelucida still intact. Vesicular stomatitis virus was not. The committee recommended that extensive field trials such as that planned by USDA, to move embryos from Brazil to the U.S. be encouraged and supported to provide adequate statistical data on the safety of this procedure.

**Virus Showering—“Evidence of the Role of Culex Pipens in Recovering Latent AHSV From Dogs in Egypt”**

Dr. Albert J. Luedke presented information concerning the recovery of African Horse Sickness (AHS) virus from dogs that harbored latent African Horse Sickness Virus (AHSV). Virus recovery was made possible by first allowing virus-free *Culex Pipens* mosquitos to feed on the dogs. This action resulted in sufficient virus being released in the blood stream so that virus recovery was possible. This mechanism for virus recovery is similar to that demonstrated for Bluetongue virus (BTV) where the bites of virus-free Culicoides *varipennis* have stimulated the “showering” of BTV
FOREIGN ANIMAL DISEASES

into the blood stream of some carrier cattle. The information presented was extracted from a book titled “Final Technical Report” by the principal investigator, professor, Dr. Sayed A. H. Salama, Director of the Veterinary Serum and Vaccine Research Institute, Cairo, Egypt, 1984. Professor Salama’s work was sponsored by the U.S. Agriculture Research Service and was financed with funds made available through Public Law 480.

Transfer of Some Plum Island Animal Center (PIADC) Activities From Agriculture Research Service (ARS) to the Animal and Plant Health Inspection Service (APHIS)

Dr. Donald Luchsinger informed the committee of the transfer of certain PIADC activities from ARS to APHIS. The activities transferred were diagnosis, training and reagent production and included the personnel involved in conducting those activities and the facilities and equipment pertinent to the activity. Dr. Luchsinger emphasized that the transfer was accomplished smoothly and with maximum cooperation between ARS and APHIS.

Applications of New Information Technology

The FAD committee was asked to consider how new information technology could be used to help increase the awareness of FAD by individuals most likely to confront an initial case. This, in turn, would significantly strengthen our defense and quick response to an incursion of FAD.

Export systems, computer-assisted learning programs, video compact discs with interactive software and electronic libraries are examples of new technology, available today, that could help out FAD training and improve awareness of FAD.

The committee was encouraged to support the applications of this new technology and consider an integrated plan, involving the USAHA, federal, state, and university-based experts, to initiate prototype efforts to judge the merit of new systems and evaluate the potential for a more broad based usage.

Foreign Animal Disease Manual

A Booklet entitled “Emergency Animal Diseases Eradication Manual for the Caribbean with Emphasis on Foot-and-Mouth Disease” provided by the Pan American Health Organization, was distributed to interested committee members and guests.

WORLD STATUS OF ANIMAL DISEASE EXOTIC TO THE UNITED STATES

Drs. W. W. Buish and J. T. Cavanaugh

Foot-and-Mouth Disease (FMD)

Africa: The veterinary authorities in many West and Central African countries have been occupied by attempts to control rinderpest. As a
result, many of the FMD control programs have received a lower priority.

In South Africa, serotype SAT2 virus was isolated in November from impala located at the Kruger National Park. The last reports of SAT2 isolates from South Africa were reported in 1983. In Kenya, the incidence of FMD increased and the virus serotypes still prevalent were SAT2, O, A, and C. Burundi reported outbreaks caused by types SAT2 and O. Outbreaks caused by type A were reported in Cameroon, Ethiopia (a marked decrease in incidence), and in the Sudan (a marked increase in incidence). Type O was reported in Malawi and Tanzania. SAT1 was reported from positive probang samples taken from buffaloes in Malawi and tested at the Botswana Vaccine Institute. There were no reports of SAT3 virus isolates. Chad, Djibouti, Libya, Nigeria, Senegal, and Zaire all reported cases of FMD, but virus types were not identified.

With the establishment of the Vaccine Institute in Botswana as an official regional center for FMD, it has been possible to increase the number of FMD investigations, especially from wildlife. The production and distribution of FMD vaccine from the institute is also of great assistance.

The America's: Chile continues to report freedom from FMD since the last outbreak reported in May 1984. Brazil and Argentina continue to report the presence of virus types A, O, and C. The field situation has improved considerably in Argentina due to the use of vaccines containing the C3 Argentina 84 strain.

In Colombia, however, there has been a considerable increase in the number of outbreaks due to the appearance of a new strain of serotype A (A Sabana Col/85) in the savannah areas of the Andean mountains.

Asia: FMD continues to be enzootic in many of the Asian countries. The serotypes involved are still limited to O, A, C, and Asia 1. Control programs are proceeding in several countries but there is still a lot of work to be done in order to achieve control and final eradication of the disease. The establishment of a regional FMD laboratory, possibly at Nong Sari in Thailand, would be of great assistance in this regard. Asia 1 was reported for the first time in Malaysia and was reported in Pakistan after a 9-year absence. The distribution of Asia 1 in Asia between 1981 and 1985 shows a marked increase in the number of countries reporting the disease (three in 1981 and seven in 1985). In recent years the disease has gradually progressed toward Europe.

Europe: Outbreaks of FMD serotype A were recorded throughout Italy from November 1984 through August 1985. The virus responsible was serotype A and some of the early isolates were shown at the World Reference Laboratory at Pirbright to be indistinguishable from the A5 Parma virus strain used for vaccine production. FMD serotype C was diagnosed in November 1985 and outbreaks due to this serotype continued throughout Italy until April 1986, primarily in swine. Fingerprinting
FOREIGN ANIMAL DISEASES

analysis by Pirbright showed that type C Italy/85 field strain is indistinguishable from C1 Brescia/69 vaccine strain and very different from C Argentina/84, C3 Resende and, C1 Noville strains. Since June 1986, a number of outbreaks of type A and one outbreak of type O have been reported in the northeast, northwest, and central regions of this country. As a result of above situation, on September 2, 1986, the European Community (EC) Veterinary Committee placed a ban on Italian exports of livestock and meat from all counties (small Italian administrative divisions) where FMD has been confirmed. Yugoslavia has also placed a ban on the importation of all Italian livestock and meat.

In Spain one outbreak of FMD in cattle was reported in June of this year. Forty-two animals were on the infected farm, three of which evidenced clinical signs. The virus type identified was A5 The last outbreaks of A5 in Spain were reported in 1983 and involved cattle and goats.

Turkey and the U.S.S.R. (Republics of Europe): Both reported outbreaks of FMD caused by types O and A22.

The Mediterranean Basin: In Israel there were 13 outbreaks of FMD caused by type O. The disease was restricted to two native reserves in the northeastern part of the country. Mountain gazelles which are a protected species in Israel were the main victims as well as the source of infection to the few unvaccinated domestic ruminants in their vicinity. Vesicular samples sent to the World Reference Laboratory from Jordan were shown to contain type O virus, which was indistinguishable from the strain isolated from cattle and antelopes (gazelles) in North Eastern Israel. FMD is reported to be widespread in Lebanon with types O, A22, C, and Asia 1 recorded. Control by vaccination and application of sanitary methods have been attempted, but these are limited only to free access areas in the country.

African Swine Fever (ASF)

Although, as the name implies, ASF is enzootic on the African continent, it is interesting to note that South Africa had no reported cases from 1981 until an outbreak in June 1985. In addition, Namibia which had not reported ASF since 1982 experienced four outbreaks in early 1986. The number of cases increased considerably in Cameroon, and cases were reported in Angola, Malawi, Zaire, Uganda and Zambia.

In Europe ASF entered the Netherlands for the first time in March 1986. Two outbreaks were confirmed and no additional cases have been reported since April 1, 1986. Illegal feeding of uncooked garbage appears to be responsible for the introduction of the virus. It was in March 1985 that ASF entered Belgium for the first time in that country's history. Belgium officials officially report the disease as eradicated — the last case having been reported in May 1985. Outbreaks of ASF continue to be reported for Spain, Italy (Sardinia), and Portugal.
REPORT OF THE COMMITTEE

Classical Swine Fever (CSF)

In Europe, Great Britain has reported CSF after freedom from the disease since 1971. The last outbreak was reported on June 25, 1986. There was a total of 10 premises from which the virus was isolated and 6 premises that were serologically positive. All animals from these premises were depopulated (a total of 7,675 swine). Other significant developments with respect to CSF this year have been the recurrence in Uruguay after a 6-year absence and in Japan following an absence of 2 years. The German Democratic Republic (East Germany) again reports the presence of CSF after a 3-year absence. In Portugal and Luxembourg the incidence has decreased in recent years, whereas it has increased in Yugoslavia. In Austria, France, Italy, Belgium, and the Netherlands, the disease seems to have a cyclic pattern. The Federal Republic of Germany (West Germany) reports the highest number of CSF outbreaks in Europe.

Rinderpest

Africa: The following countries have reported the disease: Egypt, Burkina Faso, Ivory Coast, Ghana, Mali, Niger, Nigeria, Togo, Ethiopia, and Mauritania. Both Burkina Faso and Ghana had last reported cases in 1983 and 1982 respectively. Following the widespread outbreaks between 1982–84, the number of countries reporting rinderpest has declined. However, in West Africa an increase in the number of countries as well as the actual number of outbreaks is reported.

Asia: India, Nepal, and Iraq have reported outbreaks.

Contagious Bovine Pleuropneumonia (CBPP)

In Africa CBPP was reported in the following countries: Angola, Burkina Faso, Gabon, Ghana, Namibia, Nigeria, Uganda, and Somali. Of interest is a reduction in the number of outbreaks in Ethiopia and the fact that CBPP, which recurred (after an 8-year absence) in the Central African Republic in 1984 spread further in 1985.

In Europe the recurrence in 1983 of CBPP in Portugal after a 23-year absence continues to cause a significant number of outbreaks. In France and Spain, however, no cases have been reported since 1984.

Rift Valley Fever (RVF)

Rift Valley Fever remained limited to the Sub-Saharan regions of Africa. Due to the continued drought, no outbreaks of importance were reported in southern Africa. The only countries that have submitted positive reports are South Africa and Zimbabwe. RVF was isolated from mosquitoes in Senegal in 1983, however, no clinical case of the disease has been reported. Mauritania is also considered infected. Initial serological screening on livestock in Ethiopia demonstrated the presence of a low percentage of positive animals.
FOREIGN ANIMAL DISEASES

Lumpy Skin Disease (LSD)

The only significant developments were reported in Madagascar where the number of outbreaks increased. South Africa and Ethiopia recorded a marked decrease in incidence. LSD is also reported from Malawi, Gabon, Kenya, Zaire, Zimbabwe, and Zambia.

Sheep and Goat Pox

In Africa the disease was reported in Egypt (previous reported outbreaks 1982), Ivory Coast (previous reported outbreak 1983), Burkina Faso, Djibouti. In Asia a significant decrease in outbreaks occurred in Iran, and the outbreaks in Turkey continued at a very high level.

African Horse Sickness (AHS)

The disease was reported from South Africa, Botswana, Lesotho, Zimbabwe, and Ethiopia. Recurrence of AHS was reported in Ghana and Senegal where the disease had not been reported since 1983.

Teschen Disease

Is reported from only two countries—Madagascar and the U.S.S.R.

Swine Vesicular Disease (SVD)

In August 1984 a single outbreak was reported in Italy. Since then and after a year of reported absence throughout the world, the Federal Republic of Germany reported an outbreak in October 1985. The World Reference Laboratory for Foot-and-Mouth Disease, Pirbright, United Kingdom, reported five positive samples for SVD submitted from Hong Kong during 1985.

Dourine

Is reported primarily from the following African countries: South Africa, Namibia, Swaziland, Lesotho, Botswana, Chad, and Ethiopia. In Asia, Burma, Iraq, and Iran have reported dourine as has Bolivia, the only country in the Western Hemisphere to do so.

Glanders

Is reported from India, Nepal, Burma, and Iraq in the Asian area and, occasionally, from Swaziland and Mauritania in Africa as well as from Italy and Turkey in Europe.

RESEARCH ON VESICULAR DISEASES

Dr. Donald O. Morgan

The scope of this review is limited to a selected group of references which illustrate research trends (1985–1986) on viral vesicular diseases of veterinary importance. These diseases are: Foot-and-Mouth Disease (FMD) [Picornaviridae, Aphthovirus (FMDV)]; Vesicular Stomatitis (VS) [Rhabdoviridae, Vesiculovirus (VSV)]; Swine Vesicular Disease (SVD) [Picor-
naviridae, Enterovirus (SVDV); Vesicular Exanthema of Swine (VES) [Caliciviridae, Calicivirus (VESV)].

**Foot-and-Mouth Disease (FMD)**

The reports of research on FMD (i.e. the disease itself) in economically important animals were rather limited in number last year. There was a detailed study on the FMDV infection of the bovine mammary gland that demonstrated the infection and rapid recovery of secretory cells.10

Chile has now been free of FMD for more than 2 years. On the other hand, there was a high incidence of FMD (types A, O and C) in Italy involving swine to a much greater degree than usual. Swine were vaccinated under a special mandate which will be removed when the crisis is over.5

Several species of wild animals have been reported to exhibit persistent FMDV infection (i.e. the carrier state) although in many cases proof of transmission of infection between carrier and susceptible animal has been less than straightforward.3,4,5,9,12 Cell cultures persistently infected with FMDV have been “cured of this infection” through the use of Ribavarin. Experiments are being planned to evaluate the potential of this drug for altering the course of FMDV infection in animals.14 This could have a rather large impact on regulations which are based upon the potential danger of movement of “carriers.”

Antigenic analysis of FMDV through the use of monoclonal antibodies (Mab’s) is being performed in several laboratories.6,18,21,24 Current data appear to indicate that panels of Mab’s offer a greater benefit for diagnostics and epidemiology than single Mab’s.11 Development of bovine and porcine derived Mab’s is being actively pursued in several laboratories. These Mab’s offer a solution to the problem of species differences in antigenic specificity which has hampered practical application of results based solely on murine antibodies. Anti-idiotypes to FMDV neutralizing antibodies have been developed in both rabbits and cattle and a very modest anti-viral activity has been demonstrated with the rabbit antibodies.7,8 At this point the utility of anti-idiotypic antibodies appears to be restricted to research applications.

The RNA polymerase (virus infection associated antigen—VIAA) of several FMDV serotypes has been shown to have very similar or identical amino acid sequences.20 This tends to confirm the serologic results which show that this is an antigenic entity shared by all FMDV’s. Biochemical properties of both a virulent and an attenuated strain of FMDV were compared. The outstanding difference was a shorter Poly-C tract in the attenuated strain.23 New FMDV strains of importance in the field potency of vaccine were reported this year (a type C in Argentina and a type A in Colombia).1,2

Detailed FMD vaccination programs consistently point up the need for
FOREIGN ANIMAL DISEASES

more definitive data concerning the vaccination of young animals.\textsuperscript{13,16,22} Reports on the influence of colostral antibody on FMD vaccination are conflicting. However, it seems quite clear that the young calf or pig, not nursing an immune dam, is capable of a meaningful response to vaccination during the first month of life. The response of these young animals is not sustained and they should be revaccinated at around 60 days of age. There is considerable concern that the FMD vaccine innocuity test should require more than the simple absence of clinical signs of FMD.\textsuperscript{25} Studies in Germany (using approved commercial vaccines) have demonstrated that 10\% of the vaccinated cattle failed to mount a significant immune response even after 4 successive vaccinations.\textsuperscript{17}

Cattle have been immunized, in the case of both types A and O, with a single dose of synthetic peptide, representing a sequential epitope.\textsuperscript{15,19} More complex peptides which represent conformational rather than sequential epitopes offer greater promise as practical FMD immunogens.\textsuperscript{18} Several “live” vaccine vectors are being evaluated. The nucleotides encoding for VP1 of FMD have been incorporated into the genome of vaccinia virus and expressed during vaccinia infection; however, no proof of protection has yet been demonstrated.

\textbf{Vesicular Stomatitis}

The current and enormous literature of Vesicular Stomatitis relates in the main to the use of its etiologic agent in molecular biology and not to animal disease. Antibodies to VSV were detected in both white-tailed deer and feral swine.\textsuperscript{1,2} Escape mutants were selected by the use of polyclonal anti-VSV sera in tissue culture procedures. The antigenic mutations which enabled these “mutants” to survive were demonstrated, through the use of monoclonal antibodies, to exist on the surface of the spike glycoprotein.\textsuperscript{3} The N-protein, an internal protein of the virion, is expressed on the surface of VSV infected cells. This antigen serves as a major target for the “VSV” specific cytotoxic T-cells.\textsuperscript{5} An ELISA capable of detecting immunoglobulin M antibody to VSV in sera from cattle and horses which had undergone either experimental or natural VSV infections was developed. The detection of IgM permitted an estimate of the recency of infection by VSV.\textsuperscript{4}

\textbf{Swine Vesicular Disease (SVD)}

The only report of an SVD outbreak this year was one from the German Federal Republic, the disease was “stamped out” on that farm.\textsuperscript{1} A killed SVD vaccine was produced and shown to be effective upon evaluation.\textsuperscript{2,3}

\textbf{Vesicular Exanthemia of Swine (VES)}

There were not reports on VES turned up in this years literature search.
REPORT OF THE COMMITTEE

REFERENCES

Foot-and-Mouth Disease


FOREIGN ANIMAL DISEASES


23. Polacino, P., Kaplan, G., Yafal, A. G. and Palma, E. L. Biochemical Character-
REPORT OF THE COMMITTEE


**Vesicular Stomatitis**


**Swine Vesicular Disease**


INTRODUCTION

Potomac Horse Fever (PHF) is a disease of horses of all ages which was first recognized in Montgomery County, Maryland, in 1979. Affected horses usually develop a high fever (102–107°F), become depressed, eat less which is often followed by a severe life-threatening diarrhea and/or colic; laminitis is a frequent sequel, often necessitating euthanasia. The disease has also been referred to as Potomac Valley Fever and Acute Equine Diarrhea Syndrome (AEDS), among other names. In Maryland alone between 1982 and 1984 there have been 338 reported clinical cases, with 88 deaths. The disease is distinctly seasonal, with most cases occurring between May and November. During this same three-year period approximately 73% of cases have occurred during the months of July and August.

The disease, once thought to be confined to the Potomac River valley of Maryland and Virginia, is now known to occur in many regions of the United States. The characteristic epidemiological pattern and the typical clinical signs of the disease have been reported by veterinary practitioners throughout the United States. PHF has been confirmed in at least 13 states including Ohio, Pennsylvania, West Virginia, Virginia, Maryland, New Jersey, Illinois, New York, Wisconsin, Idaho, Minnesota, Kentucky, Florida, California, Connecticut and Canada by the isolation of the causative organism or the demonstration of specific antibody in affected or recovered horses.

DIAGNOSTIC TESTS

A diagnosis of Potomac Horse Fever may be made in at least four different ways: 1) clinical examination; 2) routine clinical laboratory examination; 3) antigen detection techniques; and 4) antibody detection techniques.

The clinical signs of PHF may be sufficiently discrete to “tip off” an experienced veterinarian, but to the unexperienced clinician are similar to several acute diseases of horses including salmonellosis (which can occur concurrently), intestinal obstruction, viral arteritis, peritonitis and verminous arteritis.
The onset in most affected horses begins with depression and anorexia. The horse is usually febrile (102–107°F) and may have injected mucous membranes and prominent episcleral injection. Intestinal gas (borborygmal) sounds will be noticeably decreased or absent in the early stages of the disease. In 24 to 72 hours a profuse, watery diarrhea may develop which may continue for up to 7 days, but in most cases lasts only 3–5 days. Signs of laminitis, if they occur, begin most commonly after the onset of diarrhea, or rarely before the occurrence of diarrhea. In 1983, laminitis was clinically significant in 25% of the cases, often resulting in euthanasia for humane considerations. Since the clinical signs strongly resemble salmonellosis, multiple samples of fecal matter should be submitted to a laboratory for culture. If all samples are negative for salmonella then Potomac Horse Fever should be given serious consideration as one of several other causes of acute diarrhea in horses.

Although the majority of cases follow the typical course described, a few do not. Some have transient depression and fever as the only signs. Some cases are febrile (increased temperature), have decreased borborygmal (intestinal) sounds, very injected mucous membranes, abdominal distention and severe abdominal pain (colic). The pain may be so severe as to resemble a horse requiring surgical correction due to an intestinal obstruction. Rarely horses may die before diarrhea develops. The most consistent signs in all cases are depression, fever, and decrease in borborygmal (intestinal) sounds.

Routine clinical laboratory examinations may be diagnostically helpful but not definitive. During the acute phase of the disease most horses have a neutropenia and lymphopenia. The pattern is often biphasic (Ziemer ref) but not consistent among horses. Following the onset of diarrhea affected horses become dehydrated and hemoconcentration is evidenced with the increase in the packed cell volume (PCV) and total plasma protein. The more severe the diarrhea the greater the laboratory aberrations. Some acutely affected horses become hypocalcemic which may be of clinical significance but not diagnostic for PHF.

Animal detection methods are often sensitive specific methods to confirm a diagnosis of PHF but may be slow, cumbersome, and expensive. Electron microscopic examination of the tissues and/or peripheral blood offers a specific diagnosis. However, the tissues (colon) must be prepared with care and experience is needed to detect Ehrlichia risticii in the tissue or blood monocytes. This technique serves only research projects and not routinely available to the practicing veterinarian (Ref).

Centrifugation of peripheral blood through a ficolle hypaque density gradient will concentrate the infected monocytes and with cytocentrifuge serves as a means to further concentrate the organism which are easily stained with hemacolor or Giemsa stain (Ziemer ref). Additionally, an appropriate fluorescent antibody stain could be used to stain the orga-
POTOMAC HORSE FEVER: DIAGNOSTIC TESTS

nisms within the infected monocytes. An alternative method has been the attempt to culture the peripheral blood in special tissue culture chamber slides for 48 hours then stain the Ehrlichia following their growth. This technique has offered some success and is being developed further (Ziemer ref).

Culturing *E. risticii* in tissue culture flasks is possible but still requires some means to identify the infected cells since cytopathic effect (CPE) is not a feature of Ehrlichia-infected mouse macrophages P-388E, the preferred host cell.

Animal inoculation with infected blood from a suspect clinical case offers a diagnostic possibility. Typical clinical signs occur in susceptible ponies about 9–16 days PI. An experienced clinician can recognize the typical clinical signs in susceptible animals, however, seroconversion or demonstration of the antigen in the susceptible pony must be done to confirm the diagnosis.

A recently developed ELISA test offers some advantages over the IFA test which requires a cell line with infective organisms on a glass slide, a highly skilled technician and expensive fluorescent microscopy equipment. The ELISA test offers the advantage of completing a large number of samples in a day and should be more reproducible than the IFA test.

During the acute phase of the disease the practitioners has a limited means to make a definitive diagnosis. Blood taken from a clinical patient could be injected into a susceptible research pony, however, it would be 10–16 days before the pony would show typical signs if the suspect animal was positive. Attempts to demonstrate the causative agent in the peripheral blood monocytes is rarely possible using stains to identify rickettsia, for example, acridine orange, or giemsa stains and high power (1,000–1,500×) examination of the buffy coat cells.

One promising diagnostic technique is to harvest peripheral blood aseptically, separate the macrophages on a density gradient, and grow them in tissue culture media which allows the organism *E. risticii* to proliferate in the macrophages, enhancing their ability to be detected following staining with acridine orange or giemsa stain. Another potential diagnostic test is the intraperitoneal injection of blood or buffy coat cells from a clinical case into mice. Several strains of mice appear susceptible including Swiss Webster ICR strain, BalbC and Sprague-Dawley. Similar to susceptible ponies, the mice begin to show clinical signs on day 10–16 post inoculation which consist of rough hair coat, huddling in the corner of the cage and diarrhea. Thus, due to the time course of events a laboratory animal as the test vehicle provides little diagnostic advantage for the practitioner.

Another but yet unproven diagnostic test is direct fluorescent antibody to detect the organism in peripheral blood monocytes. This diagnostic
approach is being pursued, but at this time has not been adequately developed.

REFERENCES


REPORT OF THE COMMITTEE ON INFECTIOUS DISEASES OF HORSES

Chairman: Dr. C. L. Campbell, Tallahassee, FL
Vice Chairman: Dr. R. C. Knowles, Rehoboth Beach, DE

Dr. J. B. Anderson, TN; Dr. J. Castaneda G., SA; Dr. L. Coggins, NC; Dr. A. M. Creswell, TN; Dr. B. H. Espe, OK; Dr. C. A. Gipson, VA; Dr. J. B. Healy, CA; Dr. F. M. Jones, FL; Dr. M. J. Kemen, NY; Dr. W. O. Kester, CO; Dr. M. J. McDonald, KY; Dr. W. D. Miller, VA; Mr. M. J. Nolan, DC; Dr. S. R. Nusbaum, NJ; Ms. M. A. Owen, MA; Dr. W. E. Face, FL; Dr. L. Schlater, IA; Dr. M. B. Teigland, FL; Dr. C. D. Vail, CO; Dr. T. E. Walton, CO; Dr. R. D. Welsh, TX; Dr. R. H. Whitlock, PA.

The Committee on Infectious Diseases of Horses convened in Louisville, Kentucky, on October 20, 1986, with some 40 members and visitors in attendance. A quorum present. Numerous items of interest to the equine industry were discussed.

Dr. James Pearson reminded the Committee that this past year represented the 14th consecutive year that the National Veterinary Services Laboratories has been testing samples for the equine encephalitides as a part of the Venezuelan Equine Encephalitis (VEE) surveillance program.

In 1985, there were 7 positive WEE cases and 9 positive EEE cases diagnosed at NVSL. The Centers for Disease Control (CDC), Ft. Collins, Colorado, reported 55 EEE and 6 WEE positive cases. The total of CDC and NVSL positive cases was 13 WEE and 64 EEE. CDC reported one human case in Texas that had a seroconversion against WEE virus in mid-October 1985.

In December, 1985 an outbreak of equine encephalitis was reported on a ranch in Yucatan, Mexico. Twenty-eight of 31 samples submitted to NVSL were positive for VEE antibody. VEE HI titers were as high as 1:320. The samples were forwarded to CDC at Ft. Collins, Colorado. They tested the serums against different strains of VEE virus. They could not identify the strain but did report it was similar to the TC83 vaccine strain of the VEE virus. CDC collected insects and blood samples from various species. No evidence of the epizootic strain of VEE was detected. The enzootic strain has been found in this area previously.

In 1986, there have been 21 positive WEE cases and 23 positive EEE cases diagnosed at NVSL. CDC has reported an additional 13 cases of WEE and 50 cases of EEE. The total of NVSL and CDC positive cases was 73 EEE and 34 WEE.

In conclusion, there were few cases of WEE and EEE diagnosed at NVSL in 1984 and 1985. However, in 1986 there were outbreaks of EEE in Florida, Louisiana, and Mississippi. There were 7 positive cases of WEE in
Kansas and scattered cases in other western states. There is still no evidence of the virulent subtype of VEE in the U.S.

Dr. P. J. Timoney presented a status report on equine viral arteritis in Kentucky advising that during 1986 there have been no clinical cases of the disease confirmed. With respect to inapparent or asymptomatic infection, there were two additional stallions confirmed as shedders, so the current status of actively shedding stallions in the state of Kentucky stands at 16. He further reported very good success with their current virus isolation procedures and, in summation, stated that this marks the second consecutive breeding season since 1984 when the outbreak of EVA occurred that investigators have been unable to demonstrate any cases of the clinical disease associated with the circulation of this virus in Kentucky's thoroughbred stallion population.

Dr. D. G. Powell advised the Committee of increasing interest taking place in the need for establishing an international infectious disease reporting system. He stated that there was a consensus that more factual emphasis be placed upon disseminating broader information on the non-notifiable diseases from a global viewpoint.

You have just heard a report on a disease of emerging importance—that of Potomac Horse Fever. Much discussion took place upon this disease and the tests which are being developed to detect its presence. Dr. Ralph Knowles advised that he had written to the Secretary of Agriculture voicing his concerns in several areas in dealing with PHF. He read to the Committee a response from the Office of the Secretary which stated that APHIS is now in the process of evaluating the latex agglutination test and that further research upon the disease is being conducted by ARS in Beltsville.

To this end your Committee has prepared two resolutions relative to Potomac Horse Fever which will be considered by this body on Friday morning.

The Committee concluded until the latex agglutination test for Potomac Horse Fever has been fully evaluated and approved, that regulatory officials, practicing veterinarians and industry should move cautiously in restricting horse movements based solely on serological results.

Dr. C. A. Gipson reported on the incidence of equine infectious anemia in the United States in Fiscal Year 1986. His chart enumerating these cases will appear as a part of this report.

Dr. Gipson further reported on the experimental equine piroplasmosis project which has been conducted jointly by USDA and Washington State University. Details of this project have been published in the American Journal of Veterinary Research, Volume 47, Number 8, August 1986.

In considering the proposed contagious equine metritis amendments appearing in the September 4, 1986 issue of the Federal Register, the
Committee offered the following language in lieu of the currently proposed language appearing in the first column on page 31638, paragraph (3): "That the mare has not been bred to a stallion in the year in which the stallion was known to have been contaminated with the CEM organism nor in the following year."
Two relatively new technologies are having a great impact on the direction of animal agriculture programs. The one with which animal health personnel are most familiar is that of biotechnology; the second, which is the topic of my talk today, is that of electronics and computers as they relate to animal agriculture.

Livestock production applications

A number of applications for electronic identification for livestock production are shown in Table I. Electronic identification units come in many sizes and with a variety of technological features. The most common method for attaching them to the animal is around the neck. Electronic ID units first started to appear commercially in the US about 1979 and are now offered by a wide number of dairy equipment companies, primarily for dispensing concentrates on an automatic, individual basis. Recently some units have appeared that are small enough to be encased in an ear tag, and at least two companies are offering units that are made for subdermal implantation. The first units were passive, that is, no batteries, but we now recognize that battery powered units are an acceptable technological approach for these systems. Most of the systems use an electronic pulse code for encoding the electronic ID. A recent new technology under development for this purpose is the surface acoustical wave being developed for marketing by Allflex Ear Tag Co.

The commercial development of electronic identification thus far has been primarily for applications related to livestock production. Automatic grain dispensing and automatic recording of milk weights in the milking parlor are commercial realities at this point. Automatic weighing of animals is currently under development and likely will become available commercially within the next several months. A particular development is the commercial availability of an animal scale suitable for plug in compatibility with an electronic identification system. Such a system is currently under field test by Tru-test and can be linked to a number of electronic identification units, the main requirement being that animals should be able to be identified automatically as they walk across the scale.

Agricultural product companies are also in the process of developing prototype units for automatic detection of subclinical mastitis linking electronic ID with an inline milk conductivity sensor and are developing sensors for automatic detection of estrus. Automatic detection of estrus has been shown to be feasible by two methods. In one method an activity
ELECTRONIC IDENTIFICATION

monitor is used to determine increased activity at the time of estrus; a second method is the use of an implantable tissue hydration sensor which monitors increased tissue hydration at the time of estrus, a change which is under the influence of estrogen.

Developments during the past year

During the last year several developments have taken place. Three companies, Boumatic, Germania, and De Laval now offer walk-through identification as a commercial method for identifying cows in the milking parlor. This is a significant advancement since it allows automatic collection of data in the milking parlor, particularly milk weights, with a high degree of accuracy in automatic cow identification. This system depends on the cows staying in the same order after they pass through a portal area in which they are identified. It requires a very high accuracy of identification in order to be a significant improvement over manual identification. Reports from the field indicate that the systems may achieve in excess of 99% correct identifications with this approach.

A second development during the past year is additional work toward units suitable for ear mounting in livestock. Eureka Systems, Division of Senelco Inc., from Slough England has established a US subsidiary at Englewood Cliffs, New Jersey and has committed to pursue the livestock market in the US. This system uses a small battery powered electronic identification unit which can be mounted in an ear tag which is suitable for either cattle or swine. Two other companies, Imperial Chemicals Inc. (ICI) and Cotag have similar units which are suitable for ear mounting. ICI committed to pursue the US swine market upon the completion of their field test and the development of commercial volume manufacturing for their units. The Allflex unit, the lightest of the group, has undergone substantial commercial testing during the past year and should appear commercially on the market during the next several months, especially for applications with animal weighing. A third development is the improvement of current systems to where they would be plug compatible; that is, the physical installation of the units would be such that they would not require on-site tuning and they could be physically installed by people with no electronics experience.

Animal health applications

Applications for electronic identification for animal health are shown in Table II. In contrast to the livestock production applications, these remain primarily goals for the system rather than accomplished facts. Applications include the trace back of diseased carcasses to the original herd of origin when diseased carcasses are found at the slaughter house. Disease certification of animals for import and export and the identification certification for disease eradication are other potential applications. All of these uses require a permanent system and low cost to enhance adoption.
The current electronic identification units are, for the most part, not permanent and the ones that are permanent have a short range of interrogation. Furthermore, the units are all too expensive to be used in a mandatory program at this point in time. The approach that appears to be most attractive for computerized traceback of diseased carcasses at the moment is bar coded back tags. Recent developments in this area were reported by Dr. Watson at the livestock identification committee meeting. One of the particular applications for certification of import-export animals is that of certifying disease free status for parrots. Parrots are imported in large volume from South America and may have Newcastle disease. Certification of disease free status for individual birds may be accomplished with the use of small implants such as the implantable ID units manufactured by Identification Devices Inc. and marketed by Tamar (see animal identification committee report).

**Special purpose uses**

Electronic identification also has a number of special uses in the research and regulatory area. We received a request in the past year for electronic identification of zoo animals. Such a system, which would require a permanent attachment of the identification unit to the animal, would be linked to a data base with the idea of being able to monitor with a high degree of accuracy individual animals which were used for mating or were sorted for various other purposes without physically catching the animals and giving them a tranquilizer to ascertain their identification.

A second specialized use is that of identification of laboratory research animals. This application is linked to emerging regulations concerning the identification and record systems for all types of animals that are used in laboratory research. This system requires a permanent identification linked to a data base. A final application of electronic identification is for certification of identification of livestock. Such applications are highly desirable and were the impetus for the formation of some of the first electronic identification companies. The identification of race horses is a current market that is a good example of this approach. It obviously could be used for purebred animals of all breeds and species if such a system were permanent, easy to use, and relatively cheap. Electronic imaging using a digitized picture is another approach that is emerging for this particular application, Figure I.

In summary, we can now say that archway or portal identification is technically achievable. The technology is such that we can accept passive units or those with long life batteries (units with the life of 5 to 10 years or feasible) and implants with electronic identification attached to sensors are commercially feasible.
### Table 1. Electronic ID Applications for Livestock Production

<table>
<thead>
<tr>
<th>Application</th>
<th>Features and Specifications</th>
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<tbody>
<tr>
<td>Automatic grain dispensing</td>
<td>Mostly neck mounted, some ear or brisket implants</td>
</tr>
<tr>
<td>Automatic weighing</td>
<td>Requires walk-through ID</td>
</tr>
<tr>
<td>Recording of milk weights</td>
<td>In parlor, linked to meters</td>
</tr>
<tr>
<td>Automatic detection of subclinical mastitis</td>
<td>Linked to in-line milk conductivity sensor</td>
</tr>
<tr>
<td>Automatic detection of estrus</td>
<td>1) Integrated w/implantable tissue hydration sensor</td>
</tr>
<tr>
<td></td>
<td>2) Integrated w/ activity monitor sensor</td>
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</tbody>
</table>

### Table 2. Electronic ID Applications for Animal Health

<table>
<thead>
<tr>
<th>Application</th>
<th>Features and Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traceback of diseased carcasses</td>
<td>Requires permanent, mandatory, low cost system</td>
</tr>
<tr>
<td>Disease-free certification for import/export</td>
<td>Requires permanent system</td>
</tr>
<tr>
<td>ID certification for disease eradication</td>
<td>Requires permanent system</td>
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### Table 3. Electronic ID for Research, Regulatory and Special Purposes

<table>
<thead>
<tr>
<th>Application</th>
<th>Features and Specifications</th>
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<tbody>
<tr>
<td>ID of Zoo animals</td>
<td>Permanent, min. range of 1 M, linked to data base</td>
</tr>
<tr>
<td>ID of laboratory research animals</td>
<td>Permanent, linked to data base</td>
</tr>
<tr>
<td>ID certification of livestock</td>
<td>Permanent, low cost</td>
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Figure 1. Electronic Imaging for Livestock ID
REPORT OF THE COMMITTEE ON LIVESTOCK IDENTIFICATION

Chairman: Mr. R. E. Nelson, Brattleboro, VT
Vice Chairman: Dr. E. R. Hinshaw, Phoenix, AZ

Dr. J. B. Ashcraft, CO; Mr. P. E. Bradshaw, IL; Dr. D. R. Bridgewater, CO; Mr. D. Casey, MO; Mr. H. F. Embry, IL; Mr. R. Gadd, SD; Mr. B. Gallagher, SD; Dr. H. E. Goldstein, OH; Dr. L. Graham, MT; Dr. T. V. Haas, KY; Mr. J. N. Huff, CO; Mr. R. D. Jones, SD; Mr. G. M. Jones, NM; Mr. D. Likes, KS; Mr. M. L. Main, SD; Mr. Glee Mulder, IA; Mr. N. F. Powers, Jr., NY; Mr. G. W. Roberts, CA; Dr. E. C. Roukema, VA; Dr. M. D. Salman, CO; Mr. R. Schnell, ND; Mr. K. W. Schritchlow, IL; Dr. G. L. Snyder, VA; Dr. S. L. Spahr, IL; Mr. W. E. Stemler, IL; Dr. F. E. Sterner, CO; Dr. J. E. Thomas, AR; Dr. C. R. Watson, MD.

The Livestock Identification Committee met Wednesday, October 22, 1986, with fifty-six in attendance, including nineteen members of the committee.

Dr. Cecil Watson, USDA-APHIS-VS, presented a progress report on the pilot study of bar coding of backtags. Studies are ongoing in Colorado, Missouri, Mississippi, Kentucky, and Wisconsin. The study addresses developing the bar code backtag, development of the software (NCAHIS), acquire the hardware (NCAHIS) and make a final report. During fiscal year 1986 hardware has been delivered to the five pilot states and the software developed. The bar coded backtag has undergone several revisions and a prototype developed. The new approach in electronic identification and the reception and attitude of the five pilot states is being monitored and evaluated.

Dr. Watson also reviewed a survey of identification devices being used by each state in its regulatory programs. The report indicates the use of identification tags for individual identification of official vaccinates and brucellosis reactors being used in all states do not conform to the specifications set forth in the Code of Federal Regulations and/or Uniform Methods and Rules. Dr. Watson posed several questions to the Committee outlining the lack of a uniformity nationwide and requested Committee opinion on a number of questions to consider for increasing uniformity.

Dr. James Hodges of the American Meat Institute voiced the packing industry's continued request for mandatory identification of slaughter swine. Since 1984 the AMI has pursued their goal with regard to requiring identification of swine arriving at market in order to trace residue or diseases to the source.

Dr. David Meeker, speaking for the National Pork Producers Task Force on Identification, spoke in support of identification of swine for a variety of reasons. Dr. Meeker indicated that the NPPC position called for supporting identification of all slaughter hogs in such a manner that they can be traced to the last farm of ownership with the request for feedback on health
REPORT OF THE COMMITTEE

and carcass quality to producers. He emphasized the need for flexibility and he described their education program.

Dr. Gerald Snyder, USDA-FSIS, reported that, as a result of the broad-based support, mandatory swine identification is coming and USDA was in the process of writing a docket for proposed rule-making. The proposal will require that swine identification records be available from the packer on request by FSIS and the rules would call for ability to track pigs for 30 days before arriving at slaughter. Confidentiality of these records was discussed, and the program was to be geared to correcting and educating deficient producers rather than one of entrapment.

Questions posed by Mr. Neal Black, President of the Livestock Conservation Institute, brought forth debate on problems of administration, where the cost would fall and whether certain previously stated positions were workable, equitable or fair.

Dr. Vern Taylor of the Taymar Company demonstrated the electronic identification equipment marketed by his company with primary attention to horses at this time. The system explained consisted of a small implant inserted through a .12 gauge needle subcutaneously in swine and cattle and intramuscularly in the neck of the horse near the crest midway between the head and shoulder. The implant is read by a wand within three inches feeding through an interrogator that can record and store 13,000 individual identifications.

Mr. Richard Robinson, Agriculture Canada, reviewed the specifications for the electronic identification equipment and the evaluation of the systems presented for consideration for use in the project. A series of exhaustive bench tests were applied to each and, as a result of these testing procedures, equipment was selected but the second phase of the project was delayed pending improvements. The second phase will start with a reduced trial with 250 bulls equipped with electronic identifiers to start in the immediate future.

Dr. S. L. Spahr, University of Illinois, gave an update of electronic identification systems, many in current use. Most of the present uses are tied to electronic feeding units, particularly in dairies. Dr. Spahr presented various systems he has reviewed and their components that are available commercially, with special attention to the innovations of the past year, including walk-through read-out and electronic imaging.

Dr. Gary Seawright, President, Amteck, Inc., Los Alamos, New Mexico, presented a report on the perspective of electronic identification in industry other than livestock. Dr. Seawright's company, being deeply involved in electronic identification systems development, serves the railroads, trucking and seaboard shipping. Application to livestock of electronic identification systems must be based on specification guides with the cost of the complete system a serious consideration in selection. This company is staffed by those previously involved in the Los Alamos livestock identifi-
LIVESTOCK IDENTIFICATION

cation project and maintains interest in livestock identification.

Mr. Richard Nelson, Committee Chairman, presented slides updating the Committee on the presentation made two years ago by Dr. Gene Rouse of Iowa State University on the identification of feeder steers imported from Mexico by injecting dye in the nose with a nozzle that does not penetrate the skin. Various dosages of injected dye appear at slaughter subcutaneously when the head and muzzle are skinned identifying the injected animal.

The committee passed three “Statements of Position” which are as follows:

1. The Livestock Identification Committee of the U. S. Animal Health Association, having reviewed identification devices in use by State regulatory agencies throughout the United States, as revealed through a USDA-APHIS survey, recognizes an apparent lack of complete uniformity and/or adherence to standards specified by APHIS. Therefore, the USAHA Livestock Identification Committee requests appropriate action that will bring uniformity among all States in size and quality of device as well as in the coding or numbering system, all in keeping with existing specifications and/or requirements.

2. The U. S. Animal Health Association Livestock Identification Committee commends Agriculture Canada for the initiative it has taken in implementing field trials involving the use of electronic identification equipment in identifying livestock. Given the commonness of the livestock industry in Canada and the United States, in its totality and within specie groups and breeds, the USAHA Livestock Identification Committee recognizes merit in compatibility of national systems of electronic identification; therefore it supports monitoring developments in Canada and recognizes the advantage of compatibility of national systems in the two countries, if and when national systems of electronic identification emerge.

3. The U. S. Animal Health Association Livestock Identification Committee recognizes the coding of the Uniform Series ear tags as an existing national numbering system that is serving the industry well under past and current record-keeping and management systems. Such numbering and/or coding system may or may not be adaptable to other potential improvements in identification systems. Therefore, it is recommended that a subcommittee be appointed within the Identification Committee to study and evaluate the possible need for revision or modification and develop recommendations for such, if deemed feasible and/or appropriate.

The meeting was adjourned at 5:15 PM.
CHARACTERIZATION OF H5N2 INFLUENZA VIRUSES FROM BIRDS IN LIVE POULTRY MARKETS IN USA

Robert G. Webster¹, William J. Bean¹, Yoshihiro Kawaoka¹, and Dennis Senne²

SUMMARY
The H5N2 influenza viruses that appeared in domestic poultry in the USA in 1985–86 were characterized with monoclonal antibodies by sequence analysis of the HA (hemagglutinin) and NA (neuraminidase) genes, and by oligonucleotide mapping at the total RNAs. These studies showed that the H5N2 viruses isolated in 1986 were related to the Pennsylvania family of H5N2 isolates and are readily distinguished from other H5N2 isolates such as A/Quail/Ore/20719/86 (H5N2). The viruses are not highly pathogenic after experimental infection of chickens and replicate mainly in the respiratory tract. The H5N2 viruses showed evidence of continued variation and permitted discrimination between the different lineages. The H5N2 viruses of a particular lineage was maintained in an individual market for at least four months. The possibility exists that the live poultry markets may have been the immediate source of virus for domestic poultry in Pennsylvania both in April 1983 and in December 1985.

INTRODUCTION
The available evidence indicated that the H5N2 influenza virus that caused the disease outbreaks in domestic poultry in Pennsylvania and adjacent states was eradicated by the end of 1984 (Buisch et al., 1984). However, in December 1985 and in 1986, H5N2 influenza viruses were again isolated from domestic poultry in Pennsylvania. These viruses caused respiratory infections with tracheitis, a pronounced drop in egg production, but did not cause high mortality. Extensive epidemiological studies traced these viruses to the live poultry markets in New York City, New Jersey, and Miami and indicated that these markets may serve as a potential reservoir of H5N2 viruses.

This study addresses the question of whether the H5N2 influenza viruses from domestic poultry in Pennsylvania and from birds in the live poultry markets in 1985–86 are antigenically and genetically related to

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278
CHARACTERIZATION OF H5N2 INFLUENZA VIRUSES

the H5N2 influenza viruses from Pennsylvania in 1983–84. There have been many H5N2 influenza viruses isolated from wild birds over the past 10 years (Hinshaw et al., 1985), and it is possible that the 1985–86 strains came from these sources and not from the H5N2 strains in domestic poultry in 1983.

Molecular characterization of the 1983 H5N2 influenza viruses indicated that a critical point mutation in the hemagglutinin gene was responsible for the highly pathogenic character of this virus (Kawaoka et al., 1984; Webster et al., 1986). The question to be resolved is whether the 1986 H5N2 viruses belong to the “Pennsylvania family” of H5N2 influenza viruses. To answer this question representation virus isolates were examined by oligonucleotide mapping of their RNAs; the hemagglutinins were compared with a panel of monoclonal antibodies and partial sequence analysis of the HA and NA genes of one of the 1986 isolates was examined. The results indicate that the 1985–86 H5N2 influenza viruses belong to the same “family” of H5N2 viruses as the 1983 Pennsylvania strains but had continued to evolve.

MATERIALS AND METHODS

Viruses. The viruses were obtained from the National Veterinary Services Laboratory (NVSL) at Ames, Iowa. They had one or two passages in embryonated chicken embryos and their designations are given in the tables. The A/Chicken/Pennsylvania/1370/83 (H5N2) virus served as the prototype virulent H5N2 influenza virus. Viruses were grown in 11-day-old embryonated chicken eggs and were purified by differential sedimentation through 25–70% sucrose gradient in a Beckman SW 28 rotor. Virion RNA was isolated by treatment of purified virus with proteinase K and sodium dodecyl sulfate, followed by extraction with phenol:chloroform (1:1) as described previously (Bean et al., 1980).

The viruses used in this study were handled in a P3 containment laboratory that was approved for such use by the United States Department of Agriculture.

Specific antibodies. Antisera specific for the isolated HA and NA antigens of the reference strains of influenza A viruses were prepared in goats (Webster et al., 1974). Monoclonal antibodies to the HA and NA of many of the viruses used in this study were prepared by the method of Kohler and Milstein (1976) as described by Webster et al. (1982).

Serological tests. HA titrations and hemagglutination-inhibition tests were performed in microtiter plates with receptor-destroying enzyme-treated sera (Palmer et al., 1975). NA titrations and NA inhibition tests were done by the procedure of Aymard-Henry et al. (1973).

Animals. Adult white leghorn chickens (>30 weeks) were housed in P3 facilities and were inoculated with 0.1–0.2 ml of virus in allantoic fluid into the nares or caudal air sac. Tracheal and rectal swabs were collected 3
days later and inoculated into embryonated chicken eggs for virus isolation. The birds were checked for 8 days and were bled for serological studies two weeks after infection.

**Iodination and electrophoretic analysis of viral RNA.** The preparation and iodination of viral RNA have been described previously, Bean et al. (1980). Labeled viral RNA was resolved on a 3% polyacrylamide gel containing 7 M urea, 50 mM Tris-Borate (pH 8.3), and 1 mM EDTA. Electrophoresis was for 4 h at 1200 V. After electrophoresis, the gel was dried and exposed on Kodak XOMAT-AR film.

**Oligonucleotide mapping.** Oligonucleotide mapping of 32P-labeled RNase T1 digests of viral genome RNA and isolated genome segments was done by the method of Pedersen and Haseltine (1980) as modified by Lee and Fowlks (1982). Unincorporated ATP and small digestion products were removed by passage through a 1-ml column of Bio-Gel P-6DG (Bio-Rad Laboratories) followed by two ethanol precipitations. Isolation of viral RNA segments was carried out as described previously (Bean, 1984).

**Nucleic acid sequencing.** Nine oligonucleotide primers complementary to the virion HA gene segment of CWPend83 (H5N2) (Kawaoka et al., 1984) were synthesized on an Applied Biosystems model 380A DNA synthesizer by the solid-phase phosphoramidite method. Nucleic acid sequences were determined by reverse transcription of virion RNA in the presence of primers and dideoxynucleotides as described (Air, 1979; Naeve et al., 1984). The reaction products were resolved in 8% polyacrylamide-7 M urea thin gels in TBE buffer (90 mM Tris-borate, pH 8.0; 1 mM EDTA) as described (Maxam and Gilbert, 1977)

**RESULTS**

**Pathogenicity.** Although the H5N2 viruses isolated from poultry in Pennsylvania in 1985–86 caused mortality in the field (1–5% experimental inoculation of chickens by the oral or caudal air sac route did not cause mortality (results not shown). After oral inoculation, virus was detected in the trachea for up to 7 days; in contrast virus was inconsistently isolated from rectal samples. After caudal air sac injection, virus was isolated from both the trachea and rectum. The virus was readily transmitted to contact birds and virus was most frequently isolated from tracheal swabs.

**Analysis with monoclonal antibodies to the hemagglutinin.** Each of the influenza viruses isolated from poultry after January 1986 were identified in HI and NI tests with monospecific antiserum. The vast majority of viruses were of the H5N2 subtypes (results not shown), a minority of other subtypes were also isolated principally from ducks and will not be considered in this report.

To determine the extent of antigenic relatedness of these isolates to the Pennsylvania strains from 1983–84, they were examined with a panel of monoclonal antibodies to the HA. Representative reactivity patterns are
shown in Table 1. Some of the viruses reacted with all 21 of the monoclonal antibodies and could not be distinguished from the prototype 1983 H5N2 isolates. Other isolates from 1985–86 did not react with any of the monoclonal antibodies. The only H5N2 virus that failed to react with all of the monoclonal antibodies was A/Quail/Ore/20719/86 (H5N2). This virus reacted to H5 polyclonal sera but was also antigenically distinguishable from the prototype Ck/Penn/1370/83 strain.

These results indicate that the hemagglutinins of the majority of the isolates are related to A/Ck/Penn/1370/83 but that antigenic variation has occurred. Despite the minor antigenic heterogeneity among the 1986 isolates, it is clear that they are antigenically interrelated and clearly distinguishable from other H5N2 isolates such as A/Quail/Ore/20719/86 (H5N2).

Oligonucleotide analysis. Analysis of the HA provides information on only one of the eight genes; to determine the extent of relationship between all genes a representative number of viruses were oligonucleotide mapped.

Oligonucleotide mapping of total RNA of 25 H5N2 viruses from different species (chickens, turkeys, guinea fowl) showed that all of the strains were related to each other. However, there was sufficient diversity among them to separate them into four relatively homogeneous groups (Table 2). The strains in each group contain oligonucleotides not seen in the viruses in other groups. Strains listed on adjacent lines are very closely related with up to 2 oligonucleotide differences between them while gaps within groups indicate several differences. Thus, group 4 shows that the virus isolated from chickens in Florida in May 1986 are indistinguishable from viruses isolated in New Jersey in January 1986 but differ by several nucleotides from the Ohio and Massachusetts isolates. The viruses isolated repeatedly from February–April from a single Brooklyn market (group 2) are indistinguishable.

The four groups of viruses based on oligonucleotide mapping (Table 2) show that viruses in group 1 are from farms in Pennsylvania, those in group 2 and 3 from markets in New York, while group 4 includes viruses from Massachusetts, New Jersey, Florida, New York, and Ohio. Some of the groups included viruses isolated early in 1986 (groups 1 and 2) while the other two groups contained viruses isolated over most of the study period (January–April, 1986).

Sequence analysis of the HA and NA genes. The ultimate method of comparing viruses is by sequence analysis of their genes. Sequence analysis of 50% of the HA gene and 32% of the NA gene of A/Ck/PA/1/86 (H5N2) showed that the nucleotide sequence was 98.6% and 97.9% homologous with the prototype H5N2 strain from 1983 (Table 3). These results show that these viruses are closely related but are continuing to show variation that is typical of influenza A viruses.
DISCUSSION

There are a number of questions to be answered in these studies: (i) Did the H5N2 viruses in domestic poultry in 1985–86 originate from the same source as the H5N2 viruses prevalent in Pennsylvania in 1983–84 or from another source? (ii) How can influenza viruses be maintained in a live poultry market? (iii) Is it possible that birds in live markets were the original source of the H5N2 virus for chickens in Pennsylvania in 1983?

(i) Do the 1985–86 H5N2 influenza viruses belong to the Pennsylvania family of the H5N2 viruses?

Antigenic analysis with monoclonal antibodies to the HA, partial sequence analysis of the HA and NA, and oligonucleotide mapping all indicate that 1986 H5N2 strains are derived from the Pennsylvania-like H5N2 isolates. Antigenic analysis, oligonucleotide mapping, and sequence analysis showed heterogeneity between isolates indicating that several lines of H5N2 viruses had evolved over the years — each being interrelated to each other and deriving from some common ancestor. The Pennsylvania family of H5N2 viruses was clearly distinguishable from other H5N2 isolates such as the A/Quail/Ore/20719/86; this H5N2 strain clearly originated from some other source.

(ii) How are the H5N2 influenza viruses maintained in city markets?

Sequential analysis of influenza virus isolates from poultry in a New York market showed that antigenically and genetically indistinguishable viruses were isolated repeatedly from the same market even after one or more cycles of cleaning and disinfection. This suggested that the same H5N2 viruses were being maintained in individual markets for months and that it is possible that some infected birds were "held over" between each clearing and disinfection. Since the H5N2 viruses are transmitted mainly by the respiratory route as distinct from fecal-oral transmission they are rapidly spread to susceptible birds.

There are over 40 live poultry markets in New York City that handle in excess of 50,000 birds per week. The range of poultry in a market includes chickens of several varieties, bantams, turkeys, guinea fowl, ducks, geese, pigeons, rabbits, guinea pigs, and sometimes larger animals such as sheep; the animals are kept under crowded conditions sometimes with different species in one cage. The poultry come from surrounding states and the majority pass through a central supply market; extensive surveillance indicated that influenza viruses were not being regularly introduced into the city markets from the large commercial suppliers. In the city markets, chickens turn over within 1–5 days while guinea fowl and turkeys may stay for up to 7 days or more.

Detectable levels of H5N2 virus were present in birds from the majority of the New York markets in February and March 1986. Influenza viruses of the H5N2 subtype isolated repeatedly from the same market during
February–April 1986 were analyzed by oligonucleotide mapping and with monoclonal antibodies to the hemagglutinin. These analyses indicated that the same virus was retained in an individual market. There was presumably sufficient turnover of susceptible birds to maintain the viruses in the markets. In order to break the virus cycle within a single market, all birds were sold and extensive cleaning and disinfection has been successful in markedly reducing the number of markets with H5N2 influenza virus infections.

Since the same crates were originally used to transport different species without cleaning, it is possible that the outbreaks of disease on farms in Pennsylvania may have originated from the markets. All crates are now washed at the central market and despite extensive virus and serological studies, there is no evidence for reintroduction of H5N2 influenza viruses into the markets from the suppliers indicating that the viruses are maintained in the poultry in the markets.

(iii) Were birds in live markets the source of virus for chickens in Pennsylvania in 1983?

Sequence analysis of the HA of H5N2 influenza viruses isolated from chickens on different farms in Pennsylvania in April 1983 showed significant sequence differences (Kawaoka and Webster, 1984). From the mutation rate, it was projected that these viruses had been in domestic poultry for at least six months before April 1983 and that a single introduction initiated the outbreak. It is possible that the viruses were spread from New York markets to poultry both in April 1983 and in December 1985. How the virus got into the live poultry market remains a mystery; the most likely source would be from ducks or range-reared birds that could be infected by wild birds. The multiple different species in close contact provides ideal conditions for mixed infections with different influenza subtypes and the generation of new reassortant strains as demonstrated in vivo in laboratory experiments (Webster et al., 1973).

ACKNOWLEDGMENTS

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REFERENCES


CHARACTERIZATION OF H5N2 INFLUENZA VIRUSES

Table 2. Oligonucleotide mapping of 1986 H5N2 influenza viruses.

<table>
<thead>
<tr>
<th>Group</th>
<th>Virus</th>
<th>Date of</th>
<th>Source</th>
</tr>
</thead>
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<tr>
<td>1</td>
<td>Ck/Penn/1/86</td>
<td>7 Jan 86?</td>
<td>Farm</td>
</tr>
<tr>
<td></td>
<td>Penn/2/86</td>
<td>6 Jan 86?</td>
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<td></td>
<td>Ck/Penn/10393/86</td>
<td>30 Dec 85</td>
<td>Farm</td>
</tr>
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<td></td>
<td>Ck/Penn/13580/86</td>
<td>4 Feb 86 ?</td>
<td>Farm</td>
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<tr>
<td></td>
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<td>12 Feb 86</td>
<td>Farm</td>
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<td>2</td>
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<td></td>
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Table 3. Nucleotide sequence homology between H5N2 influenza viruses isolated in 1983* and 1986.

<table>
<thead>
<tr>
<th>Gene</th>
<th>% Sequenced</th>
<th>No. changes/No. sequenced</th>
<th>% Homology</th>
</tr>
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<tr>
<td>HA</td>
<td>50</td>
<td>11/809</td>
<td>98.6</td>
</tr>
<tr>
<td>NA</td>
<td>32</td>
<td>9/438</td>
<td>97.9</td>
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*A/Ck/PA/1370/83 versus A/Ck/PA/1/86.
Table 1. Antigenic Analysis of H5N2 Influenza Viruses With Monoclonal Antibodies Reactivity Patterns to the Following Influenza Viruses in Hemagglutination Inhibition Tests

| Monoclonal Antibodies to H5 | Ck/Pa/1370/83 | Ck/Pa/22911-10/86 | Ck/Pa/1370/86 | Ck/Pa/1370/83 | Ck/Pa/1370/86 | Ck/Pa/1370/83 | Ck/Pa/1370/86 | Ck/Pa/1370/83 | Ck/Pa/1370/86 | Ck/Pa/1370/83 | Ck/Pa/1370/86 | Ck/Pa/1370/83 | Ck/Pa/1370/86 | Ck/Pa/1370/83 | Ck/Pa/1370/86 | Ck/Pa/1370/83 | Ck/Pa/1370/86 | Ck/Pa/1370/83 | Ck/Pa/1370/86 | Ck/Pa/1370/83 | Ck/Pa/1370/86 | Ck/Pa/1370/83 | Ck/Pa/1370/86 | Ck/Pa/1370/83 | Ck/Pa/1370/86 | Ck/Pa/1370/83 | Ck/Pa/1370/86 | Ck/Pa/1370/83 | Ck/Pa/1370/86 | Ck/Pa/1370/83 | Ck/Pa/1370/86 | Ck/Pa/1370/83 | Ck/Pa/1370/86 | Ck/Pa/1370/83 | Ck/Pa/1370/86 | Ck/Pa/1370/83 |
|-----------------------------|---------------|-------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Ck/Pa/1370/83               |               |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 22                          | 12,800a       |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 28                          | 6,400         |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 31                          | 3,200         |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 34                          | 6,400         |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 46                          | 6,400         |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 52                          | 6,400         |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 55                          | 12,800        |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 58                          | 6,400         |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 62                          | 3,200         |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 63                          | 400           |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 64                          | 1,600         |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 79                          | 6,400         |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 91                          | 800           |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 94                          | 1,600         |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |

| Ck/Pa/8125/83               |               |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 176/26                      | 3,200         |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 191/4                       | 400           |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 364/5                       | 1,600         |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 406/7                       | 6,400         |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 761/11                      | 6,400         |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 777/1                       | 6,400         |                   |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |

\(^{a}\)HI titer.

\(^{b}\)No entry indicates that HI titers are not significantly different from Ck/Pa/1370/83.

\(^{c}\)Indicates HI titers are at least 10 fold lower than with Ck/Pa/1370/83.
THE FIGHT AGAINST AVIAN INFLUENZA:  
A THREE-WAY PARTNERSHIP

John K. Atwell, D.V.M.
Deputy Administrator, Veterinary Services
Animal and Plant Health Inspection Service
U.S. Department of Agriculture

We are all aware that, in today's poultry industry, more and more birds are being brought together by fewer producers and that national and international marketing patterns are growing more complex daily. These factors mean that disease outbreaks are even more threatening to us than they were in simpler days. I know that the most recent outbreak of avian influenza is on the minds of many of us. Now that it has been brought under control through the prompt and effective response of the industry, officials in the affected States, and the Animal and Plant Health Inspection Service (APHIS), I would like to talk to you about current APHIS thinking concerning the role of the Federal government in the control of avian influenza. However, before we discuss our present philosophy, I think we should take a brief look at the history and concept of disease eradication in the United States.

The U.S. Department of Agriculture (USDA), working cooperatively with States and industry, has an outstanding record in controlling and eradicating animal diseases that threaten our Nation's livestock and poultry industries. We have wiped out twelve diseases during the past 100 years, some more than once. However, the USDA did not seek this responsibility. In the early 1800's a cattle disease called contagious bovine pleuropneumonia (CBPP) was introduced into the United States. Over the years, the disease slowly spread to several States, in spite of efforts by individual States to control it. At that time, the United States exported about 100,000 cattle annually. CBPP-infected cattle were eventually exported, and our export markets were consequently lost. The livestock industry demanded that Congress take action to regain its overseas markets.

In response to this urgent situation, Congress established the Bureau of Animal Industry within the USDA in 1884. The new Bureau had the responsibility to prevent the exportation of diseased animals, prevent the introduction of animal diseases into the United States, and eradicate certain diseases that threatened livestock production.

After six costly introductions of foot-and-mouth disease (FMD) between 1900 and 1929, in 1930 Congress prohibited the importation of animals and animal products that could introduce FMD or rinderpest. Zoological specimens were the only exception. This law was tremendously effective in protecting our livestock industry from these two diseases and probably from many others as well. Congress allowed further exceptions to this
blanket restriction only after reliable diagnostic tests had been developed to detect the presence of these diseases.

This legislative history shows that the USDA has the primary responsibility for the control and eradication of certain economically devastating foreign animal diseases. Nevertheless, the States and industry clearly share in this responsibility.

We all know that disease control and eradication are extremely difficult under the best of circumstances. Success requires development of a good working relationship between the States and industry, availability of the resources that are necessary to do the job, and procedures that will lead to eradication but allow the industry to survive and rebuild.

In conducting a disease eradication effort, we must take many issues into consideration — economics, quarantines, personnel, legal authority, laboratory support, and epidemiology.

Economics are of utmost importance from several standpoints. For example, individual States may not be able to support a large-scale eradication effort, and the Federal government may need to step in to provide some of the necessary finances to protect our country’s food supply. Nevertheless, the industry in affected States directly and substantially benefits from a successful eradication effort, and the States must bear their fair share of eradication costs. These costs are usually high in the short term but relatively low over the long term because the major outlays for indemnity and personnel stop after eradication. (Examples are $56 million during 24 months to eradicate velogenic viscerotropic Newcastle disease (VVND) in California and $63 million during 12 months to eradicate avian influenza in Pennsylvania and Virginia.)

Of course, related industries will also find it more difficult to do business and experience increased costs during an eradication program because of quarantine restrictions and the measures taken to stop disease spread. In most cases, their extra costs are passed on to the consumer.

In considering the importance of quarantines to an eradication effort, we all know that area quarantines are essential to prevent disease spread to a new population. However, effective quarantines depend on industry cooperation. The industry must respect the integrity of the quarantine and find alternative ways to conduct business in the affected area if eradication is to be achieved. Initially, we must ensure that the perimeters of the quarantine area are large enough so that all affected and potentially affected premises are included.

Availability of personnel is another aspect that must be considered in any eradication program. By nature, eradication efforts are labor-intensive, and large numbers of trained personnel are necessary to achieve the ultimate goal. A few States have well staffed animal health organizations. However, even in these States, there are not usually enough people to conduct a large emergency eradication program. APHIS Veterinary
Services has personnel nationwide that can be sent anywhere in the United States to support an eradication program. For example: during the peak of the VVND program in California, over 1,200 personnel were on the rolls; Great Britain called on 10,000 personnel during an FMD eradication program in 1967–68; and during the avian influenza programs in Pennsylvania and Virginia over 40 percent of the APHIS Veterinary Services field force responded — over 1,000 Federal personnel. Also, the States, the Department of Defense, and other agencies provided personnel and equipment.

To initiate an eradication program in the first place, the Federal and State Governments must have the necessary legal authority. The enforcement of intrastate quarantine regulations is the responsibility of the States, while the enforcement of interstate quarantine and international regulations is the responsibility of the Federal government. The Secretary of Agriculture’s declaration of a National Animal Disease Emergency gives him the authority to transfer funds within the USDA or to borrow the funds needed to finance the eradication program from the Commodity Credit Corporation. The Secretary declares an extraordinary emergency only when a State cannot or will not take necessary actions to eradicate the disease. The only additional authority an extraordinary emergency provides is to place Federal quarantines on individual premises and to require the depopulation of infected and exposed animals.

Even with the necessary authority and personnel, eradication cannot be achieved quickly without the laboratory support needed to provide rapid disease detection and diagnosis so that depopulation can proceed immediately. Depopulation of infected animals stops the production of additional disease agents and prevents further disease spread. During the VVND program in California and the avian influenza programs in Virginia and Pennsylvania, State diagnostic laboratories contributed immeasurably to the achievement of eradication. Of course, our National Veterinary Services Laboratories (NVSL) in Ames, Iowa, provides diagnostic support for all domestic animal disease programs; and during an emergency, NVSL can respond quickly with expanded diagnostic support capabilities.

Epidemiology is another essential ingredient in a successful eradication program. To bring an exotic disease under control with speed and deliberation, we need to understand precisely how and where the disease is spreading. We can then help the industry take steps to protect its animals from further contagion. If the industry cooperates, we will eventually achieve eradication.

Let us now turn specifically to avian influenza. Our country has been through two separate, but related, epidemics of avian influenza in poultry in the past 3 years. In the 1983–84 outbreak, the Secretary of Agriculture declared an Extraordinary Emergency in November 1983 because the serious outbreak of fowl-plague-like avian influenza was causing high
morbidity and mortality in poultry. During this eradication effort, more than 17 million birds in 449 flocks were destroyed — 378 flocks in Pennsylvania, 69 in Virginia, 1 in Maryland, and 1 in New Jersey. Federal costs to achieve eradication amounted to a staggering $63 million.

On the other hand, the 1986 avian influenza epidemic was characterized as nonfowl-plague-like or low pathogenic, and the role of the Federal government has been to support the States and industry in their efforts to bring the outbreak under control. The States and the industry have borne the primary responsibility for locating, eliminating, and preventing the spread of disease; and we have provided diagnostic and technical assistance and monitored the progress of epidemiologic studies, with no major commitment of Federal resources. During the 1986 program, 370,000 birds in 21 commercial and backyard flocks were depopulated in five Northeastern States.

I would now like to discuss with you the factors that have influenced us in determining the current Federal approach to the control of avian influenza. First of all, we all know that the avian influenza viruses that affect poultry are well established in wild migratory waterfowl. Consequently, we must expect and be prepared for occasional reintroductions into our domestic poultry populations.

Moreover, wild captive waterfowl and domestic poultry are maintained under housing conditions that allow contact with wild waterfowl. This practice encourages the introduction of avian influenza into domestic poultry flocks — both backyard and commercial.

The avian influenza virus family is capable of altering its genotype. Over 100 different combinations of hemagglutinin (H) and neuraminidase (N) are possible.

The H5N2 virus identified in Pennsylvania and Virginia in 1983–84 was highly pathogenic in some flocks and not pathogenic in other flocks. Recent evidence indicates that certain isolates are composed of heterogenous populations of high- and low-pathogenic forms of the virus.

Avian influenza viruses cause different disease syndromes in chickens, turkeys, ducks, and captive waterfowl. Several factors determine the severity of the syndrome.

Our studies in Pennsylvania indicate that avian influenza viruses can survive in the environment for a long time. We have shown that the H5N2 virus can survive in liquid manure for 105 days.

Without the imposition of stringent biosecurity measures, current industry husbandry practices allow avian influenza viruses to spread rapidly over a large area through a variety of known vectors.

Now that we have listed the factors that have influenced the way we in the USDA view the avian influenza threat, I believe that we can safely say that the Federal actions taken during the 1983–84 epidemic were jus-
THE FIGHT AGAINST AVIAN INFLUENZA

tified. When low-pathogenic H5N2 virus was first diagnosed in Pennsylvania poultry in April 1983, we expected the States and the industry to respond to the threat. Genetic alteration in the virus might have been prevented had the industry taken decisive action at the initial outbreak to increase biosecurity. Nevertheless, when the highly pathogenic fowl-plague-like form of the disease was found, the States and the poultry industry throughout the country immediately demanded that the Federal government take emergency action.

Studies later conducted by the USDA’s Economic Research Service reinforce the fact that the Federal response was justified. These studies forecast an ultimate $5.6 billion total cost if a fowl-plague-like disease had been allowed to spread from the East Coast to the Mississippi River. Although eradication was expensive, we would have paid even more dearly without a successful program.

Although the highly pathogenic avian influenza virus was wiped out in 1984, low-pathogenic H5N2 viruses still reappear from time to time. After an outbreak in a Maryland dealer’s backyard poultry flock in December 1984, we immediately investigated about 250 other backyard flocks, but never succeeded in finding the source. In January of this year, low-pathogenic H5N2 was found in a commercial broiler flock in Pennsylvania. This time, our subsequent epidemiologic studies revealed another highly significant aspect of poultry industry marketing — the live poultry marketing industry. We have taken a long, hard look at these live bird markets and found a complex and threatening situation. However, the States involved have accepted the primary responsibility for dealing with this problem and have taken direct action to eliminate the avian influenza virus from these markets. The USDA is supporting the States in this undertaking by providing personnel to assist in the studies and the eradication program.

Our experience in the last two outbreaks shows that H5N2 avian influenza viruses can cause variable morbidity and mortality in our domestic poultry populations. The only thing we can count on is that no two outbreaks will ever be exactly the same. As a result, we need to take a close look at the roles the USDA, the States, and the industry should assume when an outbreak occurs. We are currently considering several recommendations that have a bearing on this issue.

It is being recommended that eradication should be the goal when fowl-plague-like disease breaks out in any domestic poultry population or a less severe avian influenza occurs in chickens. However, no eradication attempt would be made when low-pathogenic forms of the virus occur in any other poultry population unless there was a threat to commercial chickens. No eradication program would be undertaken in response to the presence of the disease in wild, free-flying birds.

The recommended goals for the control of fowl-plague-like disease are
such that outbreaks would be treated in the same way as outbreaks of other exotic diseases ranging from foot-and-mouth disease to African swine fever. Response would include the declaration of an emergency and the formation of an appropriate State-Federal-industry task force.

To accomplish the recommended goals for the control of nonfowl-plague-like disease, we believe that the Federal role should be one of furnishing diagnostic and epidemiologic support and providing advice and guidance in any eradication or control effort. We believe the States should maintain a surveillance program based on antibody detection and flock health to monitor the incidence of disease. The States would also need to monitor any eradication effort and do everything possible to prevent the introduction of avian influenza inside their borders by establishing and enforcing requirements for the movements of birds, eggs, equipment, and cages into the State.

At this point, I cannot overstate the importance of the industry’s responsibility to institute scrupulous sanitation and biosecurity measures as the first line of defense against the continuing threat of avian influenza from waterfowl, seabirds, backyard flocks, and the live-bird markets, which are supplied by small independent operations. The success of any avian influenza control effort depends on the industry’s willing cooperation with accepted biosecurity procedures and the industry’s recognition that breeches of the established barriers can jeopardize the government’s ability to control or eradicate this troublesome disease.

In summary, the Federal government, the States, and the poultry industry must unite in a three-way partnership to fight the continuing threat of avian influenza. The responsibilities of each partner are separate, but they are definitely interrelated, and all must be fulfilled effectively if we are to succeed. I appreciate the opportunity to share with you today the Federal view of how that partnership should work.
REPORT OF THE COMMITTEE ON TRANSMISSIBLE DISEASES OF POULTRY AND OTHER AVIAN SPECIES

Chairman: Dr. R. A. Bankowski, Davis, CA
Vice Chairman: Dr. F. R. Craig, Salisbury, MD

Dr. W. W. Adams, GA; Dr. R. E. Baer, OH; Dr. A. K. Bahl, NC; Dr. W. C. Baisley, GA; Dr. C. W. Beard, GA; Dr. S. L. Clubb, FL; Dr. R. J. Eckroade, PA; Dr. M. Friend, WI; Dr. H. M. Gholi, AR; Dr. H. E. Goldstein, OH; Dr. E. E. Grass, MD; Dr. L. C. Grumbles, TX; Dr. D. A. Halvorson, MN; Ms. R. Hanessian, MD; Dr. R. L. Hogue, IN; Dr. D. C. Johnson, GA; Dr. I. H. Kahan, PA; Dr. D. D. King, MD; Dr. H. N. Lasher, DE; Dr. D. J. Ligda, IN; Dr. E. T. Mallinson, MD; Dr. R. H. McCapes, CA; Dr. D. A. McMartin, CA; Mr. M. Meyers, DC; Mr. T. R. Mickle, GA; Dr. W. D. Miller, VA; Dr. C. D. Murphy, IA; Dr. K. V. Nagaraja, MN; Dr. T. D. Njaka, WV; Dr. H. M. Opitz, ME; Dr. J. E. Pearson, IA; Dr. Irvin L. Peterson, MD; Dr. R. E. Pitts, DE; Dr. B. S. Pomeroy, MN; Dr. T. B. Ryan, NC; Dr. Glenn H. Snoeyenbos, MA; Mr. J. W. Thomas, SC; Dr. H. W. Towers, Jr., DE; Mr. W. T. Tramel, MS; Dr. D. N. Tripathy, IL; Dr. S. A. Vezey, GA; Mr. C. R. Weston, NH; Dr. T. H. Woods, AR; Dr. R. Yamamoto, CA.

The Committee met at 1:30 PM on October 21, 1986, and October 22, 1986. A total of twenty-seven members and thirty-two guests attended.

NEWCASTLE AND OTHER DISEASES OF IMPORTANCE

Newcastle Disease

Velogenic viscerotrophic Newcastle disease was not diagnosed in poultry of United States origin during FY 1986.

The importation of pet birds into the United States continues to point out potential sources of introduction of VVND. In FY 1986, eight lots of birds in commercial quarantine stations were diagnosed as infected with Velogenic or VVND by virus isolation. The birds originated from India, Indonesia, Malaysia, Peru, Philippines, Tanzania, and West Germany. All eight lots were refused entry.

Smuggling continues to flourish in birds as well as other commodities. In FY 1986, U.S. Customs Service seized seven lots of birds which were positive for VVND while in quarantine. Six of these seizures were on the Mexican border. The total number of seized birds is not available nor is the number of successfully smuggled birds known.

There were nine isolations of VVND made from pet birds in the United States. It is presumed that these were smuggled birds because they had the typical history. Two were from pet stores and the others from private homes.

Last year, the Advisory Committee on VVND approved a Veterinary Services (VS) proposal to revise the regulations on VVND. This revision...
REPORT OF THE COMMITTEE

would allow VS to weigh epidemiological and risk factors in determining the danger of VVND exposed birds. Such a regulation change was proposed, but was not approved by VS legal counsel. The entire regulation is being rewritten to overcome those objections.

**Chlamydiosis**

A severe outbreak of chlamydiosis occurred in Minnesota this year. The problem was first noted when several processing plant workers on the eviscerating line became ill over one weekend. There has been a total of ten and possibly more flocks which have been found to be infected. These flocks were processed in three different slaughtering plants and 70–75 plant workers were diagnosed as having the disease. A veterinarian and five farm workers were infected after working with diseased birds.

A turkey flock in California was diagnosed as having chlamydiosis on the processing line. No human cases were reported.

**Salmonella pullorum**

Records of *S. pullorum* isolations are kept on a calendar year rather than a fiscal year. In calendar year 1985, there were 20 isolations of *S. pullorum* from 11 States. All were from flocks of 250 birds or less. There were two isolations made from parrots and two isolations from guinea fowl and the remainder from chickens.

From January 1, 1986, through September 30, 1986, there were 80 cases of *S. pullorum*. Of these, 63 cases, or 79 percent, are cases due to hatchery dissemination, 14 percent are of unknown origin, and 7 percent are still pending. There were four commercial flocks involved. Turkeys were involved in two cases, but they were not in commercial flocks. These cases have involved 24 States.

*Salmonella gallinarum* has not been isolated in the United States since 1981. We are aware that Mexico is experiencing severe problems with *S. gallinarum*. The situation is being watched while we search for a means to help that country control the problem.

**Rhinotracheitis in Turkeys**

Dr. D. Alexander presented a talk on the outbreaks of rhinotracheitis that began in June 1985 in Great Britain. The disease began in a single owner’s turkey flock exhibiting respiratory signs and a sudden drop in egg production. The disease spread rapidly in all areas of the country and was associated with placement of started poults. All ages became involved. The morbidity was 90% with mortality ranging from 0.4% to 50%. Dead and morbid birds exhibited sinusitis, conjunctivitis, rhinitis, pericarditis, coli septicemia, and air saculitis. Although several virus types were isolated, only an embryo lethal unidentified agent from yolk sac inoculated embryos produced the typical disease. Morexella, alcaligenes fecalis, as well as other bacteria, have also been incriminated as causal agents, but estab-
lishment of the etiology or whether the disease is egg transmitted are inconclusive at this time.

Importation of turkey hatching eggs into the U.S. from Great Britain has been suspended (November 1985). Work is underway to develop diagnostic tests and to determine if the disease exists in the U.S.

**Paramyxovirus**

Paramyxovirus-3 (PMV-3) continues to be a concern for production of breeder turkeys. There is usually no clinical disease in meat type birds, but there can be a marked drop in egg production in breeder hens. The virus is reported to spread slowly between houses; however, the spread continues even where there is good biosecurity. An inactivated vaccine is available under a conditional license for farms that have a high potential risk of infection. The vaccine has been approved for use in California, Minnesota, North Carolina, Colorado, Ohio, Oregon, Washington, Virginia, and Pennsylvania. The vaccine was also used in Canada. The amount of vaccine used is over twice what it was last year.

PMV-3 was identified at the National Veterinary Services Laboratories from 16 pet birds. Four were submitted for diagnostic purposes, 12 were isolated from birds submitted for Newcastle disease virus surveillance. The virus was isolated from Arizona, Maine, New Jersey, Florida, South Carolina and Maryland.

Paramyxovirus Yucaipa (PVM-2) was isolated from a turkey flock in southern California. The turkeys suffered from a mild respiratory disease condition with a bacterial infection.

**Mycoplasmosis**

The Subcommittee, under the excellent leadership of Dr. Michael Optiz, expressed strong concern for the lack of progress made toward the eradication of mycoplasma from large, multiple-age layer operations; inconsistency of arrangements among States for handling “controlled exposure” of egg-type pullets; and problems with conventional serological testing, including lack of plate and HI antigen sensitivity in detecting slow spreading mycoplasma infections. The following recommendations were submitted:

1. Government and industry agencies should increase efforts toward improved biosecurity at all production levels.

2. Employ the concept of the use of a USDA-licensed, commercially produced, live F-strain or other approved MG strains for “controlled exposure” of table-egg pullets, provided that its use be under the control of proper State officials.

3. Problems of specificity and sensitivity of plate agglutination and hemagglutination antigens should be investigated immediately by USDA.
The above recommendations were unanimously approved by the members of the full Committee. However, there were strong expressions of concern about the use of live mycoplasma vaccines in table-egg pullets as a hazard to the turkey and broiler industries and as a deterrent to progress in the total eradication of MG from the table-egg industry.

MODEL STATE PROGRAM FOR PET BIRDS

No progress was made on federal enablement legislation for the implementation of the NCABIP program, as put forth by the Subcommittee with the support of USAHA over the past three years. However, a major breakthrough can be reported on a state-local level. The State of Maryland has developed and implemented the MPBI Program. This has been brought about under the guidance of Dr. Archibald Park of the Maryland Department of Agriculture, the efforts of the Maryland Extension Service through Dr. E. T. Mallinson, along with the cooperation of Mrs. Lee Phillips, the avicultural groups and pet shop owners in that state.

Other states, including Virginia and Maine, are also evolving model state bird improvement plans of their own. Hopefully other states will follow in much the same vein.

The Model State Subcommittee no doubt served as the initial impetus for the current state plan. It is felt that the Subcommittee should continue and increase its efforts to further the adoption of plans in other states leading eventually to a national plan. A Model State cage and aviary bird plan is essential to avoid restrictive legislation present in some states and being considered by others regarding the pet bird industries.

AVIAN INFLUENZA

Avian Influenza in FY 86

A detailed report on avian influenza during the past year was made by the chairman of the subcommittee, Dr. Ben Pomeroy.

On January 8, 1986, avian influenza virus (H5N2) was isolated from a chicken flock in Pennsylvania. During the next 12 weeks a total of two turkey flocks, 11 chicken flocks and two flocks containing guinea fowl and chukars were depopulated in Pennsylvania. One commercial poultry operation in New Jersey, one in Massachusetts, one in New York and two dealers in Ohio were identified infected with H5N2 and depopulated. Through State action H5N2 has been eliminated from poultry flocks in Pennsylvania, New Jersey, New York, Massachusetts and Ohio. Twenty flocks totalling more than 368,000 birds were destroyed.

The infection in commercial poultry resulted from direct or indirect contact with live poultry markets in New York City and New Jersey. Extensive state activities eliminated H5N2 virus from New Jersey, Rhode Island and Connecticut live poultry markets by depopulation followed by cleaning and disinfection. In New York City, most market operators were reluctant to remain free of birds for longer than 24 hours at a time. By
following a regimen of 24-hour depopulation, followed by cleaning and disinfection, all markets eventually were cleaned up.

H5N2 was also detected in the live poultry markets in Miami, Florida. The live bird market in Miami was found to be different from the New York City/New Jersey market. The sales of live birds are made from "botanicas" which sell a variety of items including various live animals, including chickens, guinea fowl, turkeys, quail, pheasants, pigeons, other exotic birds and animals. The botanicas service the needs of individuals who practice various forms of santeria or voodoo.

All isolates pathotyped at NVSL-APHIS-USDA were considered non-pathogenic or low pathogenic. Fingerprinting studies at WHO Influenza Center, St. Jude Children's Research Hospital indicated the H5N2 1986 isolates were similar to Pennsylvania H5N2, 1983.

**Need for Improved Biosecurity Management Programs**

The lessons learned in the outbreaks associated with live poultry markets indicate that these markets as well as auction and flea markets and dealers in poultry are a real health hazard to the commercial poultry industries in the U.S. It is a challenge to state and federal animal health authorities in cooperation with the commercial poultry industries to make every effort to improve biosecurity management programs in all segments of the commercial poultry industries including live poultry markets, auction and flea markets and dealers in poultry.

**Commendations**

The State Animal Health authorities in the states involved with H5N2 outbreaks in 1986 are to be commended for their swift aggressive action in eliminating H5N2 from the commercial poultry flocks in their respective states and instituting improved biosecurity management programs in the live poultry markets to decrease the threat of avian influenza and other infectious avian diseases to the commercial poultry industries.

USDA-APHIS-VS is commended for its support of the State Agencies in furnishing diagnostic and epidemiologic support and providing advice and guidance in the eradication effort.

The commercial poultry industries in the states involved are commended for their support to the State and Federal Agencies in the eradication efforts and the development of improved biosecurity management programs for the live poultry markets.

**turkeys**

Avian influenza was identified in turkey flocks in Colorado (H9N2), Minnesota (H1N1, H2N7, H4N6, H4N8, H5N2, H5N7, H7N3 and H9N9), Pennsylvania (H1N1), Utah (H6N8, H10N9) and Wisconsin (H2N7). These isolates that were pathotyped at NVSL were nonpathogenic in chickens.
Guinea fowl and chukars were found infected with H5N2 and guinea fowl with H1N1, H6N8 in Pennsylvania.

Quail were found infected with H5N2 in Oregon. The isolate was pathotyped and found nonpathogenic and fingerprinting studies indicated it was not related to Pennsylvania H5N2.

Ducks were found infected with H4N6 in Maryland in October, 1985.

A summary of the AI isolates from turkeys, chickens and other domestic fowl in the United States 1964–1986 or based on serology is found in Table 1.

Dr. J. E. Pearson of NVSL submitted the following report on avian influenza viral isolations and positive serology cases from October 1, 1985, to September 30, 1986.

The first isolation of avian influenza H5N2 was made from a Pennsylvania submission collected December 30, 1985. Virus was isolated from 12 premises in Pennsylvania, 8 in Florida, 16 in New Jersey, 27 in New York, 1 in Ohio and 1 in Rhode Island. The virus was isolated from 105 submissions from chickens; there was at least one chicken isolate from each state. There was more than one submission from some of the premises. H5N2 was also isolated from the following species: turkeys from Ohio, Pennsylvania, New York, and New Jersey (25 submissions); guineas from New York and New Jersey (33 submissions); quail from New York and New Jersey (15 submissions); ducks from New York and New Jersey (6 submissions); chukars from Pennsylvania (1 submission); pheasants from New York (1 submission); pigeons from New York and Florida (2 submissions); bantams from New York and New Jersey (3 submissions); one goose from Ohio and New York and environmental samples from Pennsylvania, New Jersey, and New York (14 submissions).

In addition to the above, H5N2 was isolated from quail which were submitted in March from one premise in Oregon. Dr. Webster reported that the Oregon H5N2 virus differed from other H5N2 isolates. The virus did not spread to other birds on the same premise.

The following other subtypes have been isolated. All that do not have dates were made in 1986.
TRANSMISSIBLE DISEASES OF POULTRY

<table>
<thead>
<tr>
<th>State</th>
<th>Subtype</th>
<th>Species</th>
<th>Number of Isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pennsylvania</td>
<td>H3N6</td>
<td>Duck 6/3/85</td>
<td>1</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>H3N8</td>
<td>Duck 10/3/85</td>
<td>1</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>H1N1</td>
<td>Guinea</td>
<td>1</td>
</tr>
<tr>
<td>New York</td>
<td>H1N1</td>
<td>Duck</td>
<td>1</td>
</tr>
<tr>
<td>New York</td>
<td>H4N6</td>
<td>Duck</td>
<td>14</td>
</tr>
<tr>
<td>New York</td>
<td>H4N6</td>
<td>Environment</td>
<td>2</td>
</tr>
<tr>
<td>New York</td>
<td>H6N1</td>
<td>Duck</td>
<td>1</td>
</tr>
<tr>
<td>New York</td>
<td>H6N2</td>
<td>Duck</td>
<td>11</td>
</tr>
<tr>
<td>New York</td>
<td>H6N2</td>
<td>Environment</td>
<td>1</td>
</tr>
<tr>
<td>New York</td>
<td>H6N6</td>
<td>Duck</td>
<td>3</td>
</tr>
<tr>
<td>New York</td>
<td>H6N9</td>
<td>Duck</td>
<td>4</td>
</tr>
<tr>
<td>New York</td>
<td>H9N1</td>
<td>Duck</td>
<td>1</td>
</tr>
<tr>
<td>New Jersey</td>
<td>H4N6</td>
<td>Duck</td>
<td>1</td>
</tr>
<tr>
<td>New Jersey</td>
<td>H6N1</td>
<td>Duck</td>
<td>2</td>
</tr>
<tr>
<td>New Jersey</td>
<td>H6N2</td>
<td>Duck</td>
<td>2</td>
</tr>
<tr>
<td>Minnesota</td>
<td>H2N7</td>
<td>Turkeys 11/27/85</td>
<td>6/10/86</td>
</tr>
<tr>
<td>Minnesota</td>
<td>H4N6</td>
<td>Turkeys 11/27/85</td>
<td>6/10/86</td>
</tr>
<tr>
<td>Utah</td>
<td>H6N8</td>
<td>Turkeys 11/15/85</td>
<td>6/10/86</td>
</tr>
<tr>
<td>Utah</td>
<td>H10N9</td>
<td>Turkeys 9/18/86</td>
<td></td>
</tr>
<tr>
<td>Wisconsin</td>
<td>H2N7</td>
<td>Turkeys 2/6/86</td>
<td></td>
</tr>
</tbody>
</table>

Of all isolations made in Fiscal Year 1986, only ten of the H5N2 subtypes killed one or two of the eight chickens inoculated.

Other isolations of viruses of the myxovirus family made by NVSL from birds imported and held in the quarantine stations are summarized in Table 2.

Use of Avian Influenza Vaccine FY 86

Influenza killed vaccine was used in turkeys in California (H6), Colorado (H9), Iowa (H1), Missouri (H1), Minnesota (H1, H2, H4, H5, H6, H9), North Carolina (H1), Ohio (H1), and Wisconsin (H2). No chicken flocks were reported vaccinated with AI vaccine. Over 3,000,000 doses of vaccine were used in FY 86.

Miscellaneous

Other topics and areas of interest concerning avian influenza that were brought before the Committee were as follows:

Dr. Charles Beard reported on the Second International Symposium on Avian Influenza which was held at the University of Georgia, Athens, Georgia, on September 3–5, 1986. The highly successful program was attended by 150 delegates representing 15 countries and 28 states. Proceedings of the program, presentations, and discussions are scheduled to be published and available by January 1, 1987 or soon thereafter.

Dr. D. Alexander reported on a recent unofficial meeting of a group of scientists of the countries in the European Common Market. The objec-
REPORT OF THE COMMITTEE

tives were to develop definitions of avian influenza and procedures for the control and eradication of the infections which would allow unhindered trade between countries. If adopted and implemented, their recommendations would have a profound impact on imports into European Common Market countries.

Dr. C. Beard reported on experimental work done in the Southeastern Poultry Research Laboratory in Athens, Georgia. They concluded that we are working with impure populations of avian influenza virus isolates that contain virions which are highly virulent and are capable of causing erratic mortality patterns.

Dr. R. Webster reported on his biochemical investigations that indicate avian influenza viruses are heterogeneous and contain virions with incomplete, interfering components which appear to be associated with virulence.

Following an extensive discussion by the Committee, there was no clear agreement on an acceptable definition for the different pathotypes of an AI virus. Therefore, a committee was appointed by Chairman Bankowski to review alternatives and recommend appropriate definitions which will permit control and eradication and action that will allow unhindered trade between countries. A report for their study is due at the 1987 annual meeting of the USAHA.

The following subcommittees were formed:

**AVIAN INFLUENZA:** R. A. Bankowski; C. Beard; F. Craig; D. King; D. Halvorson; J. E. Pearson; I. Peterson; and B. S. Pomeroy, Chairperson

**MYCOPLASMA:** D. Johnson; E. T. Mallinson; H. O. Opitz; B. S. Pomeroy; I. Peterson; W. Towers; R. Yamamoto; and D. McMartin, Chairperson

**MODEL STATE PROGRAM FOR PET BIRDS:** R. E. Baer; R. Davis; H. Goldstein; S. Clubb; D. J. Ligda; E. T. Mallinson; M. Myers; L. Phillips; T. Tramel; and H. Kahan, Chairperson

**PARAMYXOVIRUS EVALUATION:** C. Beard; I. H. Kahan, D. King; J. E. Pearson; C. Weston; R. A. Bankowski; and D. Alexander, Chairperson

**DEFINITION OF AVIAN INFLUENZA:** D. Alexander; C. Beard; F. Craig; J. E. Pearson; B. S. Pomeroy; R. Webster; and R. A. Bankowski, Chairperson

300
<table>
<thead>
<tr>
<th>State</th>
<th>Year First Identified</th>
<th>Hemagglutinin Antigens Identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turkeys</td>
<td></td>
<td></td>
</tr>
<tr>
<td>California</td>
<td>1964</td>
<td>H5, H6, H9</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>1965</td>
<td>H6</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>1965</td>
<td>H2, H5, H6, H9</td>
</tr>
<tr>
<td>Minnesota</td>
<td>1966</td>
<td>H1, H2, H3, H4, H5, H6, H7, H8, H9, H10</td>
</tr>
<tr>
<td>Washington</td>
<td>1967</td>
<td>H6</td>
</tr>
<tr>
<td>Oregon</td>
<td>1970</td>
<td>H6, H7</td>
</tr>
<tr>
<td>Iowa</td>
<td>1971</td>
<td>H1, H4, H5, H6</td>
</tr>
<tr>
<td>Colorado</td>
<td>1972</td>
<td>H1, H5, H9</td>
</tr>
<tr>
<td>Ohio</td>
<td>1975</td>
<td>H1</td>
</tr>
<tr>
<td>South Dakota</td>
<td>1978</td>
<td>H1</td>
</tr>
<tr>
<td>Texas</td>
<td>1979</td>
<td>H5, H7, H9</td>
</tr>
<tr>
<td>Missouri</td>
<td>1980</td>
<td>H1</td>
</tr>
<tr>
<td>Kansas</td>
<td>1980</td>
<td>H1</td>
</tr>
<tr>
<td>North Dakota</td>
<td>1981</td>
<td>H5</td>
</tr>
<tr>
<td>Arkansas</td>
<td>1981</td>
<td>H1</td>
</tr>
<tr>
<td>North Carolina</td>
<td>1982</td>
<td>H1</td>
</tr>
<tr>
<td>Virginia</td>
<td>1983</td>
<td>H1, H2, H5, H10</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>1983</td>
<td>H1, H5</td>
</tr>
<tr>
<td>1986</td>
<td></td>
<td>H1, H5</td>
</tr>
<tr>
<td>Michigan</td>
<td>1985</td>
<td>H1</td>
</tr>
<tr>
<td>Utah</td>
<td>1985</td>
<td>H6</td>
</tr>
<tr>
<td>Chickens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alabama</td>
<td>1975</td>
<td>H4</td>
</tr>
<tr>
<td>Minnesota</td>
<td>1978</td>
<td>H6</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>1983</td>
<td>H5</td>
</tr>
<tr>
<td>1986</td>
<td></td>
<td>H5</td>
</tr>
<tr>
<td>Maryland</td>
<td>1983</td>
<td>H5</td>
</tr>
<tr>
<td>1984</td>
<td></td>
<td>H5</td>
</tr>
<tr>
<td>New Jersey</td>
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<td>H5</td>
</tr>
<tr>
<td>1986</td>
<td></td>
<td>H5</td>
</tr>
<tr>
<td>Virginia</td>
<td>1983</td>
<td>H5, H7</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>1986</td>
<td>H5</td>
</tr>
<tr>
<td>New York</td>
<td>1986</td>
<td>H5</td>
</tr>
<tr>
<td>Chickens—Live Market</td>
<td></td>
<td></td>
</tr>
<tr>
<td>District of Columbia</td>
<td>1980</td>
<td>H1</td>
</tr>
<tr>
<td>1984</td>
<td></td>
<td>H5</td>
</tr>
<tr>
<td>Connecticut</td>
<td>1986</td>
<td>H5</td>
</tr>
<tr>
<td>Florida</td>
<td>1986</td>
<td>H5</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>1986</td>
<td>H5</td>
</tr>
<tr>
<td>New Jersey</td>
<td>1986</td>
<td>H5</td>
</tr>
<tr>
<td>New York</td>
<td>1986</td>
<td>H5</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>1986</td>
<td>H5</td>
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301
REPORT OF THE COMMITTEE

<table>
<thead>
<tr>
<th>Chickens—Dealer</th>
<th>1986</th>
<th>H5</th>
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<tbody>
<tr>
<td>Ohio</td>
<td></td>
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</tr>
<tr>
<td>Other Species</td>
<td></td>
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</tr>
<tr>
<td>Pennsylvania</td>
<td>1969</td>
<td>Ducks, NA, H3</td>
</tr>
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<td>Minnesota</td>
<td>1974</td>
<td>Geese, NA</td>
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<td></td>
<td>1974</td>
<td>Guinea Fowl, NA</td>
</tr>
<tr>
<td></td>
<td>1980</td>
<td>Pheasants, H3, H7</td>
</tr>
<tr>
<td>New York</td>
<td>1978</td>
<td>Ducks, H3, H4, H5, H6, H11</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>1983</td>
<td>Guinea Fowl, Quail, H5</td>
</tr>
<tr>
<td>Maryland</td>
<td>1984</td>
<td>Ducks, Guinea Fowl, H3</td>
</tr>
<tr>
<td></td>
<td>1984</td>
<td>Chukar, H5</td>
</tr>
<tr>
<td></td>
<td>1985</td>
<td>Ducks, H4</td>
</tr>
<tr>
<td>Washington</td>
<td>1985</td>
<td>Pheasant, H9</td>
</tr>
<tr>
<td>Virginia</td>
<td>1985</td>
<td>Ducks, Swans, Geese, H7</td>
</tr>
<tr>
<td>Oregon</td>
<td>1986</td>
<td>Quail, H5</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>1986</td>
<td>Guinea Fowl, H1, H6</td>
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<tr>
<td>Pennsylvania</td>
<td>1986</td>
<td>Guinea Fowl and Chukar, H5</td>
</tr>
</tbody>
</table>

NA—NOT AVAILABLE
### TRANSMISSIBLE DISEASES OF POULTRY

Table 2. Isolations Made from Imported Birds FY85 and FY86 — NVSL, Ames, Iowa

<table>
<thead>
<tr>
<th></th>
<th>1985 (Fiscal Year)</th>
<th>1986 through September 20th (Fiscal Year)</th>
</tr>
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<tbody>
<tr>
<td>Lots—Private Facilities</td>
<td>223</td>
<td>202</td>
</tr>
<tr>
<td>Specimens:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Facilities</td>
<td>28,785</td>
<td>24,710</td>
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<tr>
<td>USDA Facilities</td>
<td>1,536</td>
<td>2,593</td>
</tr>
<tr>
<td>HAV Positive Lots</td>
<td>*</td>
<td>47</td>
</tr>
<tr>
<td>HAV Isolates</td>
<td>1,164**</td>
<td>978**</td>
</tr>
<tr>
<td>PMV-2 Isolates (%) of total HAV)</td>
<td>663(57.0%)</td>
<td>**</td>
</tr>
<tr>
<td>PMV-3 Isolates (%) of total HAV)</td>
<td>208(18.9%)</td>
<td>**</td>
</tr>
<tr>
<td>VVNDV Positive Lots:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Facilities</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>USDA Facilities</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Confiscated Bird</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>VNDV Positive Lots:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Facilities</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Confiscated Birds</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Lentogenic NDV Positive Lots:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Facilities</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Confiscated Birds</td>
<td>0</td>
<td>3</td>
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</tbody>
</table>

*Not available

**Typing of HAV isolates not completed
INTRODUCTION

This proposed four-stage program leading to Free status is an opportunity for producers to be actively involved in solving a serious problem. It is based on the conviction that (1) technical knowledge is available to eradicate pseudorabies from the domestic U.S. swine population, (2) given the commitment and leadership of pork producers eradication is attainable, and (3) eradication is in the best interest of the swine industry. As states progress in the program, freer interstate movement will be possible.

It should be remembered that (1) this is a proposed plan for review by the industry, (2) any plan must be submitted to legislative bodies for consideration in obtaining authorities and funding, (3) the plan assumes that there will be a public commitment to eradicate PRV, and (4) to the extent that federal funding is contemplated, the plan is based on cooperative agreements between the federal and state governments.

Entry into the program would be voluntary on the part of any state and decisions on advancing from one stage to another would be made by individual states as their situations warrant.

It is expected that individual state programs will vary, and that there may be variations between areas in a state and between herds, depending on:

1. Prevalence of the disease;
2. The type of hog industry or operation: farrow-to-finish, feeder pig production, feeder pig feeding, seedstock producer;
3. Production systems: outdoor or enclosed confinement;
4. Hog concentration;
5. The needs and desires of the industry, including state regulatory officials.

A major recommendation involves the formation of state PRV committees by pork producers in cooperation with state animal health regulatory agencies. These committees should include producers, technical advisors and state animal health regulatory agencies (state departments of agriculture or state boards of animal health). In some states such committees may already exist. It is important that such committees are broadly representative of all segments of the swine industry, including all organizations which have an interest in or could contribute to the success of the program.

The stages of the proposed plan are:

Stage 1 — Preparation, during which industry-wide state PRV committees will be organized by pork producers in cooperation with state animal
health regulatory agencies. In states in which producer leadership is lacking, state animal health regulatory agencies will organize the committees. Prevalence of the disease will be measured, as a guide to decisions on future actions and regulations, and legislative authority needed for the program will be reviewed.

Stage 2—Control, during which states will implement surveillance programs to find infected herds, quarantine such herds and, if they choose, begin a voluntary program of eliminating the virus from infected herds.

Stage 3—Continuation of voluntary stage and beginning of mandatory herd cleanup, during which owners of infected herds will be required to develop and implement individual plans to eliminate the virus from their herds. During the second part of this stage, if only a few infected herds remain in a state, depopulation of those herds could be required, with payment of indemnity as funds are available.

Stage 4—Class A, the classification of states that have completed the herd cleanup phase and have no known infected herds.

Free—States which have demonstrated freedom from the disease.

**Stage 1—Preparation**

In this stage states are encouraged to (A) form state advisory committees (B) determine prevalence of the disease as a guide to later actions, (C) assess authorities and regulations in place and needed for later stages of the program, and (D) conduct information and education programs. During this stage states should:

A. Producers should form an industry-wide state pseudorabies advisory committee in cooperation with the state animal health regulatory agency to develop a working relationship with state and local veterinary groups, swine producers and other segments affected by the program.

B. Implement a reliable system for determining prevalence of the disease in the state swine population, which might include reporting of infected herds, testing of breeding animals for change of ownership, herd testing and a survey conducted on a statistically valid sample of the swine population. Purpose of this prevalence data is to evaluate the extent of the problem and measures needed to control it in the state. The state PRV committee should determine courses of action to deal with the prevalence as determined by the system.

C. Assess state legal authorities and regulations in light of needs to accomplish state goals, including consideration in the following areas:
   1. Epidemiologic evaluation
   2. Quarantine authority and conditions under which that authority should be used
   3. Herd inspections and tests
4. Regulation of intrastate movements of breeding stock and feeder pigs
5. Control of use of vaccines
6. Identification to farm of origin of cull sows, boars and stags
7. Proper disposal of carcasses of dead animals.
8. Guidelines for herd cleanup
9. Cleaning and disinfection of premises, vehicles and equipment which have been exposed to infected hogs
10. Providing for sharing of program costs.

D. Develop a system of organized distribution of information and educational material to livestock producers and other interested groups concerning the disease and details of the PRV program.

Stage 2—Control

In this stage states commit to a control-eradication program. Goal of this stage is to determine which herds are infected with PRV and to begin to reduce the level of infection. States may enter into a cooperative agreement with APHIS specifying details of the program in that state. States in this stage should:

A. Implement a surveillance program to find infected herds, based on either slaughter testing of cull sows and boars, on-the-premises testing of every herd, or first-point testing of cull breeding animals. Such a program requires an effective identification system to permit traceback of positive animals to farm of origin.

B. Develop and plan efforts to seek necessary legislation and regulations for a program to monitor all feeder pig finishing herds. Such a program could involve a statistically valid sample of pigs in each feeding unit or a slaughter hog surveillance program which includes feeder pig finishing herds.

C. Quarantine infected herds. Positives found in a slaughter or first-point testing program would be traced to the herd of origin and additional testing and epidemiology conducted to establish infection before such herds are quarantined.

While awaiting confirmation of test results, producers would commit to an agreement to not move hogs, except to slaughter, until the herd status is determined. Placing and release of quarantines would be based on testing and epidemiologic findings.

D. Control use of vaccines, restricting or encouraging their use depending on conditions in that state.

E. States would be encouraged to conduct voluntary herd clean-up programs designed to reduce the level of infection in the state. Such programs should include funding to provide technical assistance in evaluating individual herd status, preparing herd plans and testing. Accredited veterinarians should play major roles in developing and
implementing herd cleanup plans which may involve the use of new, rapid diagnostic tests.

F. Consider the desirability of:
   1. A requirement for change of ownership testing for intrastate movements;
   2. Required testing of feeder pigs, feeder pig finishing or feeder pig production herds;
   3. Quarantined feedlots as an aid to herd cleanup.

G. Continue to:
   1. Conduct an information and education campaign;
   2. Assess and develop, where needed, regulations needed for later stages;
   3. Build swine producer commitment for advancing to the later stages;
   4. Improve epidemiologic evaluation of the PRV situation in the state.

Stage 3A—Mandatory Herd Cleanup

Through continuation of actions begun in Stage 2: ie. surveillance, quarantines and control of use of vaccines, states would eliminate infection from herds. In addition, states would begin to implement the following:

A. Required cleanup of infected herds, based on development of an effective herd plan. One of the cleanup alternatives as outlined in the LCI publication “Swine Pseudorabies Eradication Guidelines (Second Edition)” may be used. Advisory committees shall provide for time limits on developing and completing herd plans. Accredited veterinarians should play major roles in developing and implementing herd cleanup plans which may involve use of new, rapid diagnostic tests.

B. Control of all movements of swine into and within the states.

C. Implement surveillance program for feeder pig finishing herds developed as outlined in Stage 2 (B).

D. Continue to:
   1. Conduct an information and education campaign;
   2. Assess and develop, where needed, regulations needed for later stages;
   3. Build swine producer commitment for advancing to the later stages;
   4. Improve epidemiologic evaluation of the PRV situation in the state.

Stage 3B—Mandatory Herd Cleanup, Phase 2

In this stage states would continue the activities begun in Stage 3A,
SCHROEDER

involving mandatory herd cleanup of herds detected through any of the surveillance methods in effect: change of ownership testing; monitoring of feeder pigs, feeder pig production and feeder pig finishing herds; slaughter testing; first-point testing; on-the-premises testing of every herd.

A. In addition to the activities carried out in 3A, this final stage, when few infected herds remain in the state, could involve mandatory depopulation of newly infected herds or remaining infected herds in which the owners have been unable or unwilling to eliminate infection from their herd, with payment of indemnity as funding is available.

B. This stage, together with the activities carried out in Stage 3A, should qualify a state to meet the criteria for Class B status as outlined by the National Pseudorabies Control Board.

C. Continue to:
   1. Conduct an information and education campaign;
   2. Assess and develop, where needed, regulations needed for later stages;
   3. Build swine producer commitment for advancing to the later stages;
   4. Improve epidemiologic evaluation of the PRV situation in the state.

D. It is expected that states with lower classification (those in Stage 1 and 2) and states in Stage 3A, will accept feeder pigs from states in Stage 3B without further testing of either sow herds producing feeder pigs or feeder pigs.

Stage 4—Class A

This is the surveillance stage after a state has eliminated all known infection. It involves surveillance to find any infection not previously discovered or newly introduced, and cleanup of any such infected herds by procedures as outlined in Stage 3.

A. To qualify for this stage a state would meet the requirements for Class A status as defined by the National Pseudorabies Control Board (NPCB) and be so certified by that group:
   1. Operation in Stage 3A and 3B under one of the surveillance options and with ability to trace positives to herd of origin (traceback capability) as outlined by the NPCB:
      a. Slaughter surveillance of cull sows and boars for a period of two years with a traceback capability of at least 25% (percentage of population sampled multiplied by percentage of positive reactors traced), with no new confirmed cases during the second year of the testing period and no infected-quarantined herds remaining in the state at the end of the period, or
b. On-the-premises testing of every herd in the state during a period of no more than one year with no infected-quarantined herds remaining in the state at the end of the testing period.

2. Controls on vaccination and importations as outlined in NPCB standards.

B. Surveillance required during this stage would involve testing of cull breeding stock at slaughter or first point of sale as follows:
   1. For the first year with a traceback capability of 25%
   2. For succeeding years with a traceback capability of 5%

C. In the case of a confirmed outbreak, status will be suspended until 60 days after the last confirmed case has been cleaned up.

D. It is expected that all states except Free states will accept breeding stock and feeder pigs from Class A states without further testing.

**Free Status**

States will be declared Free on the basis of standards yet to be determined. It is expected that states will accept breeding stock and feeder pigs from Free states without a test on either the animals or the sow herd from which they originated.
REPORT OF THE COMMITTEE ON PSEUDORABIES

Chairman: Dr. M. H. Lang, Des Moines, IA

Vice Chairman: Mr. P. E. Bradshaw, Griggsville, IL

Dr. F. J. Alderink, MD; Dr. D. R. Bridgewater, CO; Dr. J. E. Davidson, NE; Dr. G. C. Edwards, NC; Dr. A. M. Gallina, WA; Mr. D. D. Gingerich, IA; Dr. T. J. Hagerty, MN; Dr. H. T. Hill, IA; Dr. L. W. Hinchman, IN; Mr. D. Hoogestraat, SD; Dr. C. L. Kanitz, IN; Dr. J. P. Kluge, IA; Dr. J. Nehay, CA; Dr. J. P. Quigley, GA; Dr. J. R. Ragan, TN; Mr. C. Rogers, NE; Dr. L. W. Schnurrenberger, MD; Dr. R. L. Sharee, NE; Dr. J. E. Slauter, MO; Dr. T. E. Socha, NE; Dr. P. L. Spencer, MO; Dr. D. G. Thawley, MO; Dr. E. Thurber, NE; Mr. W. H. Waldo, NE.

The meeting was called to order at 1:30 p.m., October 22, 1986, by the Chairman, Dr. Merle Lange, with 19 members and 55 guests present.

Presentations were made to the committee as follows:

Dr. Fred J. Alderink presented a summary of the economic analysis of the pilot projects.

Hilman Schroeder discussed the draft of a proposed pseudorabies eradication plan developed by a Task Force of the Livestock Conservation Institute.

Cost estimates for a 10-year eradication plan based on the pilot projects and the LCI Task Force proposal were presented by Dr. George Beran.

During a panel discussion including the speakers and others, David Meeker of National Pork Producers Council was asked about his perception of the reaction of producers to the proposed plan. He responded that producers will be discussing the proposal during local and state meetings during the next few months, culminating with action at the American Pork Congress next March. “Let’s wait and see how producers respond,” he suggested.

Neal Black indicated that future plans with regard to the proposal are to have wide discussion by all groups during the next few months. Those groups will then be asked to present their views during a hearing at the LCI meeting in April in Milwaukee by responding to two questions:
1) Do they agree that eradication is the proper course for the industry?
2) If they agree, is this proposed plan acceptable?

Alderink was asked if his cost estimates include the costs of the controls, testing and other regulatory costs incumbent with living with the disease under the present program, he said they do not.

Dr. Saul Wilson of APHIS, commented that the administration said to the industry several years ago, “Tell us what you want.” The result was the pilot projects. “Tell us what kind of program you want. We’ll respond.”

Roger Gerrits of ARS commented that the cost of eradication might be a high percentage of federal funds available for swine research.
Dr. Ralph Vinson commented that two fears evident at the January meeting in Peoria: fear of forced depopulation and time pressure, have been resolved by the proposed eradication plan and people feel better. Still needed is a track record on cleaning up large herds and that data is coming, including work in 10 herds of 500 sows or more in Illinois.

Dr. Paul Doby said Illinois is working in 150 herds, paying the cost of cleaning up and has spent only $30,000 since January, far less than expected.

Representatives from 12 states were asked to report on status with regard to the disease. They reported a great deal of activity in two areas:

1. Development and implementation of regulations, including change of ownership testing and control on feeder pig movements.
2. Voluntary infected herd clean up. Several states reported that testing to determine status and clean up long-time quarantined herds is not as expensive as expected; also that in some cases such herds are no longer infected.

Representatives of six companies reported activities in developing new biologics and diagnostic test for pseudorabies.

Dr. John Kluge moved, seconded by Dr. Charles Kanitz, that USAHA pursue with AAVLD recognition of the Latex Agglutination test as an official test. The motion carried.

Willard Waldo moved, seconded by Kluge, that the committee go on record in support of eradication of pseudorabies as a national goal and endorsing the proposed eradication plan discussed by Mr. Schroeder. The motion passed with no dissenting votes.

The committee took note of comments by members that current procedures for evaluating and recognizing official tests are obsolete and inadequate in light of emerging diagnostic technology.

The committee was pleased to receive a report from Dr. John Atwell of APHIS that $1.5 million has been added to the APHIS budget for the current fiscal year for continuation and completion of the pilot projects. These funds were added as a result of a request by the industry.

SUMMARY OF THE ECONOMIC STUDIES OF THE PSEUDORABIES PILOT PROJECTS

Fred J. Alderink
Animal Health Information Staff
USDA, APHIS, VS
Hyattsville, MD

The economic studies of the pseudorabies eradication pilot projects were implemented to aid in making the decision to either eradicate or live with the disease. Alternative clean-up methods to eradicate the pseudorabies virus (PRV) from infected herds were evaluated. Preliminary results from
the pilot projects have provided momentum for implementing pseudorabies control programs and possible eradication. The evidence of this is the September 11, 1986, draft of “PRV Control/Eradication Plan,” designed under the guidance of the Livestock Conservation Institute (LCI) and promoted by the pork industry.

The five pilot project studies have the following objectives:
1. document costs of pseudorabies to producers,
2. estimate costs to producers of eradicating pseudorabies, and
3. estimate the public costs of eradication. The research for these studies was conducted by Dr. John Ambrosius in Wisconsin, Dr. Arne Hallam in Iowa, Dr. Loren Ihnen in North Carolina, Dr. J. Louis Moore in Pennsylvania, and Dr. Allan Mueller in Illinois. Dr. James Kliebenstein also conducted an economic study in a large multiple-unit confinement operation. A summary of the methods used for data collection will be provided by the author when requested.

Caution must be exercised in the use of the results of the economic studies. The advantage of actual data from producers’ on-the-farm experience with pseudorabies comes with disadvantages. Management styles and recordkeeping vary from farm to farm and have an effect on the data collected. Still, it is data from the real world, not from controlled experiments conducted in somewhat artificial environments. Comparison of results between pilot projects must be made with the understanding there are differences in the pork industry among states and differences in the eradication programs among states.

Herd Infection Rates

The cost of eradicating a disease from an area, state or country is greatly dependent on the number of herds that are infected. The pilot projects provide some basis for estimating the number of herds infected with pseudorabies virus. As Table 1 indicates, large herds have a greater herd infection rate than small herds. Approximately 50% of the infected herds in the Illinois (IL) and Iowa (IA) pilot projects were herds with over 100 sows. However, the 1982 Census of Agriculture reported more that 80% of the herds in Macoupin and Pike Counties of IL and Marshall County of IA had less that 100 sows. A random sample of pseudorabies-negative farms in Marshall County had an average herd size of 60 sows. This agrees with the Census of Agriculture in that most pork producers in Marshall County have less than 100 sows.

The pseudorabies herd infection rate is greater in the IL and IA pilot projects than in the Pennsylvania (PA) and Wisconsin (WI) projects. The IL pilot project covered 5 and 3 townships of Macoupin and Pike Counties, respectively. There were 174 herds tested in these townships, of which 32 were determined infected on initial test, for a herd infection rate of 18.4% (Table 2). One herd was positive on a surveillance test after the initial negative test for a total of 33 infected herds. At the initiation of the pilot
PSEUDORABIES

project area testing, 16 of the 32 infected herds were known and under quarantine. As of June 1986, there were 436 herds quarantined in the State of IL. An expansion factor of 2.0 (32/16 = 2.0) suggests there are 872 pseudorabies-infected herds in the State (2.0 × 436 = 872). An alternative calculation using the 18.4% herd infection rate suggests there are more than 1,100 infected herds in the state. Twenty counties in IL have a rate of quarantined herds similar to that of Macoupin and Pike Counties. There are an estimated 957 infected herds in these counties, assuming they have 5,200 herds (5,200 × 0.184 = 957). There are 85 quarantined herds in the other 82 counties. Assuming 170 infected herds (2.0 × 85 = 170) in these remaining counties provides the estimate of 1,127 infected herds in the state. Between 870 and 1,100 infected herds in IL is the estimate suggested by the pilot project data.

The 14.6% herd infection rate for Marshall County, IA, is a prevalence rate at a point in time—December 31, 1983, (Table 2). Of 185 herds tested, there were 27 infected herds. After December 31, 1985, three additional infected herds were discovered on initial test. During the pilot project, 10 herds were found infected after being negative on an earlier test for a total of 40 infected herds.

Two assumptions are implied when the prevalence rate of 14.6% is extrapolated from Marshall County to the entire state: (1) Marshall County is representative of the state, and (2) pseudorabies is endemically stable in IA, with as many herds becoming free of pseudorabies virus as there are herds becoming newly infected. It follows that there are 5,548 pseudorabies-infected herds in IA (38,000 × 0.146 = 5,548). Twelve of 30 infected herds were known infected and under quarantine at the initiation of the pilot project area testing. As of August 1986 there were 2,205 quarantines of record in Iowa. An expansion factor of 2.5 (30/12 = 2.5) suggests there are 5,512 pseudorabies-infected herds in the state (2.5 × 2,205 = 5,512). These 2 estimates are close to each other.

The annual incidence rate of negative herds becoming infected in Marshall County, IA, was 3.72%.

\[
\frac{10 \text{ newly infected herds}}{153.6 \text{ negative herds} \times 1.75 \text{ years}} = 3.72\%
\]

The available data are insufficient to estimate a herd infection rate or number of infected herds in North Carolina (NC). There have been approximately 40 known infected herds under quarantine. There are also approximately 20 herds in which vaccine is known to be used that are seropositive and under quarantine. The pseudorabies slaughter surveillance program in NC is not reliable. During July and August 1986, 168 blood samples collected at slaughter were pseudorabies positive, but only 34 had identification. There is 70 to 80% successful tracing of identified samples to the
report of the committee

herd of origin. Tracing 26 (0.75 × 34) of 169 positive blood samples is evidence that swine identification is still a major problem.

The herd inventory for Lancaster County was used as a denominator for the herd infection rate of 8.1% in PA (Table 2). Infected herds found outside Lancaster County have been feeder pig finishers found when feeder pig sales are traced from infected herds in the county.

During 1984 and 1985, pseudorabies has been primarily in four counties of WI, with herd infection rate of less than 2% (18/1700 = 1.1). During 1984, 10 of the infected herds were in Lafayette County, which would be a herd infection rate of 2.6% in that county (10/381 = 2.6%). The assumption is made that 40 infected herds in PA and 18 in WI are reliable indications of the number of infected herds in those states during 1985.

producer costs of pseudorabies

Approximately 50% of the producers with pseudorabies virus (PRV) infected herds did not experience clinical outbreaks (Table 3). The costs to producers of pseudorabies outbreaks are itemized in Table 4. The losses occurring in the farrowing house and mortality in pigs after weaning were combined into one estimate in the PA study. Lost sales of seedstock and feeder pigs were the two largest losses in PA and WI, whereas in IA, where most producers raise hogs for the slaughter market, this loss was not reported. Loss of sales would occur on all farms quarantined, not just farms that have clinical outbreaks. Deaths in nursing pigs and before birth were substantial losses in IA and WI. Abortions caused greater losses in IA compared to WI.

Pigs that become ill with pseudorabies but do not die grow slower than normal and are known as "backward pigs." This condition was reported in IA, PA, and WI, with the greatest loss occurring in PA. Other livestock losses in PA consisted of 13 dead steers ($6,162), which involved five farms. Another farm lost eight dairy heifers ($8,000). A $400 litter of purebred puppies also died because of pseudorabies.

The average costs of $35 to $33 per sow of a pseudorabies outbreak in IA and WI are comparable. The cost per sow of $105 to PA producers is more than double the cost in IA and WI because of the loss of feeder and seedstock markets. If these two items are deleted, the cost per sow in PA would be less than $40. Six of the 41 herd surveyed in PA raised and sold seedstock. The $138-per-sow cost of a pseudorabies outbreak in IL was derived from a simulator model. Estimates by three veterinarians and four producers on the losses due to pseudorabies were entered into the computer. The model then indicated the annual return above feed costs decreased $138 per sow due to pseudorabies.

Kliebenstein, et al., studied a vertically integrated, large pork producing enterprise. Data were analyzed from 7 herds infected with PRV. Four noninfected herds, plus the records from infected herds prior to their
PSEUDORABIES

first pseudorabies outbreak, served as controls. Statistical analysis of the data indicated a 5.28% decrease in number of pigs weaned per litter during a pseudorabies outbreak. The standard deviation was 0.5 significant at the 1% level.

Increased number of mummies, decreased number of pigs born live, and mortality of nursing pigs significantly contributed to the 5.28% decrease in number of pigs weaned per litter. The increases in number of stillbirths, pigs with scours, and pigs overlaid by sows were not statistically significant. Abortions due to pseudorabies were not reported from this herd.

These losses became a direct cost of $11 per sow. Death loss in the farrowing phase caused vacant floor spaces in the growing-finishing units. The unrealized income resulting from these nonfilled spaces is an indirect cost due to pseudorabies calculated to be $16 per sow. The cost of pseudorabies in the farrowing and nursing phase of this operation is estimated to be $27 per sow (11 + 16).

The effect of pseudorabies in the finishing phase of this operation was minimal. The base used for comparison was groups of pigs not known to have pseudorabies in either the farrowing or growing-finishing phase. Slight decreases in percent liveability, feed efficiency, and a slight increase in percent pigs condemned or dead on arrival at slaughter were reported in groups of pigs negative for pseudorabies in the farrowing phase but broke with the disease in the growing-finishing phase. However, these differences were not statistically significant. The cost of producing a hundredweight (CWT) of pig was $0.88 more in this group of pigs over the control group.

Groups of pigs from farrowing units positive for pseudorabies that did not experience a break during the growing-finishing phase showed only a $0.09 per cwt cost of production increase over the controls. Pigs positive in farrowing units and that broke with pseudorabies in the growing-finishing phase showed a $0.06 per cwt decrease in cost of production. The effects of pseudorabies during the growing-finishing phase were not statistically significant in this enterprise. This is different from the empirical observations of "backward" pigs in the pilot projects and increased incidence of "pseudorabies" pneumonia on the finishing floor reported by some veterinarians.

The producers surveyed in IL and PA spent only minor amounts for isolating and testing herd additions ($9 per herd in PA). IA was the only state in which the use of vaccine was promoted and therefore was the only state in which vaccine was commonly used by producers. Their vaccine costs averaged $317 per herd. Producers in IA also spent $277 per herd to isolate and test herd additions.

WI producers who had prior experience with pseudorabies and had freed their herds of the virus spent $814 per herd per year preventing reintroduction of the virus into their herds. The expense was for isolating
and testing herd additions. Producers in WI without previous experience with pseudorabies spent $56 per herd per year to isolate and test herd additions. This amount did not vary with producers proximity to or distance from infected herds.

**Producer Costs of Eradicating Pseudorabies**

There are 3 types of eradication plans, (1) test and removal, (2) offspring segregation, and (3) depopulation-repopulation (see LCI pamphlet, “Swine Pseudorabies Eradication Guidelines 2nd ed.” for the plans). The plan used in a herd depends on several factors. The preference of regulatory veterinarians varies between states. Owners of quarantined herds have reasons for preferring a certain plan. The status of PRV in a herd may determine which plan is the most feasible. Testing the herd and selling positive animals with minimal other eradication measures is not an effective plan in herds with a high percentage of reactors and in which the virus is cycling. Depopulation-repopulation often is an efficient plan for infected feeder-pig finishing type operations. The incorporation of vaccine into a plan may increase its efficiency and is often used in the offspring segregation plan.

Data with more detail are available from the IA pilot project (Table 5). Five herds were freed of PRV using the “test and removal plan” at a producer cost of $93 per herd, or $1 per sow. The only cost to the producers was labor for testing and vaccinating. Quite likely PRV was not cycling in these herds, diagnosis were furnished through government funds, as they were in the other plans.

The 14 producers whose herds were freed of PRV using the “offspring segregation with controlled vaccination plan” did sell some breeding stock before normal culling age at a cost of $3,227 per herd. Other costs were primarily for extra labor. Facilities for segregating clean offspring from the positive herd were not an expense to these producers. They had vacant facilities that were brought into use to carry out the plan. Time required to clean up averaged 16 months.

Downtime was the primary cost to the 1 producer using the “depopulation-repopulation plan” to clean his farrow to finish herd. This is also true of this plan as used in the other states. This producer reduced downtime to 13 weeks by purchasing replacements and keeping them segregated before depopulating his positive herd. He started on an offspring segregation plan before depopulating, which is the reason for the $900 cost for labor to vaccinate.

Depopulation-repopulation is a very efficient plan to clean up feeder pig finishing operations. The producer cost per pig was only $0.30 for 3 herds freed of the virus by this method. The $490 cost for segregating recently purchased feeder pigs was for 1 producer who routinely isolated new feeder pigs to prevent introduction of swine dysentery into his herd. This cost was prorated to PRV eradication.
Table 6 shows the producer's cost of eradication in other states compared to the offspring segregation plan in IA. Downtime for depopulation-repopulation in PA averaged 7.4 months, which cost the producers $39,072. Downtime is the most expensive item in WI even though herds cleaned of PRV by test and removal without downtime were included in the average downtime cost. The cost item “depopulated” in Table 6 is the value of the breeding animals depopulated minus their salvage value at slaughter. The $53,937 cost for downtime and depopulation in IL was calculated by the simulator model for a 100-sow herd that farrowed 10 times per year. The cost was calculated as reduced returns above feed cost. The replacement of sows depopulated by bred gilts was factored into the model as well as production foregone because of depopulation. Dr. Mueller estimated 10 years would be required before a repopulated herd would recoup the costs of depopulation as compared to a vaccinated herd living with disease. He used a 10% discount rate.

The offspring segregation plan was not used in PA. The test and removal plan was used some in WI. The cost between breeding value and slaughter price of positive animals sold in WI under this plan is listed as a separate cost item.

Public Costs of Eradication

In the IA project, private practitioners were relied on to collect blood samples on the farm and to accomplish the vaccination part of the program. The practitioners were paid $15 per farm call (maximum of of 1 call per month), $2.50 per blood sample for the first 10 samples and $2.00 for each sample more than 10, $0.05 per ear tag used, and $1.25 per dose of vaccine. The laboratory fee for the SN (serum neutralization) test was $1.00 per sample. For comparison, in NC the cost was $0.90 per SN test, and the ELISA (enzyme linked immuno-sorbant assay) test was $1.26 each. Also, in NC the average cost of fee basis testing by practitioners was $2.17 per sample.

Table 7 lists these costs for pseudorabies negative and positive herds in IA. Surveillance in the pseudorabies negative herds included blood collection and laboratory fees. The cost of vaccination in negative herds is itemized separately because it is not a necessary part of a pseudorabies eradication program. Government-funded vaccination was used in negative herds to gain the cooperation of these producers in the program.

The costs for positive herds include the cost of vaccination because it was an integral part of the eradication plans, especially Plan B, offspring segregation. The costs per sow and per herd are more meaningful than the total project costs.

Table 8 shows different accounting methods were used in the different projects. The expenditures are probably high. The projects are pilot with an objective developing a more efficient and economical eradication pro-
gram. Expenses are understandably greater during the learning process. In general, the project budgets vary with the number of herds involved.

Benefits of Eradication

Obvious benefits of eradication to producers are to avoid the losses and costs due to the disease and to avoid costs of prevention. An indirect benefit, especially to seedstock producers, is to reduce to zero the risk of their herd becoming infected.

The benefit of eradicating pseudorabies to society is a reduced price of pork to consumers. Eradication of pseudorabies will improve the pork industry's efficiency in producing pork. More pork can be produced with the same amount of inputs of production. According to the T. A. Hieronymus model cited by Mueller, for each 1% increase in the supply of pork, the price of pork will decrease 1.83%. This decreased cost of pork production, with a concomitant decrease in price, will make pork more competitive with poultry and other meat products.

Discussion

The success of the 3 eradication plans requires the advice and monitoring by a veterinarian experienced with pork production and with pseudorabies. This requirement is more obvious for the offspring segregation plan because veterinarians are less acquainted with this type plan to eradicate a disease. The test and removal plan is commonly used in brucellosis eradication, and depopulation-repopulation was the principal plan used for hog cholera eradication. Veterinarians must be knowledgeable about the 3 plans before they can advise a farmer as to the advantages and disadvantages of the plans and then help him set up a plan. The offspring segregation plan requires regular monitoring over an extended period of time to be successful.

Most producers with infected herds in PA and WI would prefer to live with the disease rather than to eradicate. Whereas approximately 50% of infected herds in the pilot projects sustained clinical losses due to pseudorabies, 100% would have eradication costs under an eradication program.

Hallam explains in economic terms the preference producers with infected herds have to live with the disease rather than eradicate. He calculated the net present values (NPV) for pseudorabies outbreaks in positive herds and in clean herds and the NPV for perpetually vaccinating sows. He used the costs derived from the pilot project in Marshall County, IA, and a 10% discount rate. Producers with positive herds are assumed to experience outbreaks every 12.5 years (8% annual incidence rate of outbreaks). Using the outbreak cost of $35 per sow (Table 4), the NPV of outbreaks in infected herds is $28.50 per sow if the herd experiences the next outbreak 6.25 years from now and then an outbreak every 12.5 years. Vaccinating sows twice a year at $1.00 per head has a NPV of $20 per sow. Thus, the IA data indicate it is cost effective for producers with infected
PSEUDORABIES

herds to vaccinate. However, the average cost to producers to eradicate PRV from their herds is $29 per sow (Table 5), which is more than the NPV of vaccinating.

The impetus for a pseudorabies program must come from producers with PRV-free herds, including seedstock producers. The assumption is made that 85% of the herds in IA are PRV free (14.6% herd infection prevalence rate). The annual incidence rate of clean herds becoming infected is 3.72% i.e., 1,207 of the 32,452 clean herds become infected each year. Only 42.5% of these newly infected herds would experience clinical outbreaks. The NPV of outbreaks in clean herds is $1.78 per sow if the first outbreak occurs 31.6 years from now and then an outbreak occurs every 63.2 years. The NPV of an outbreak in a 60-sow herd is $106.80. The cost of eradication to producers with clean herds in the IA project is $30 worth of labor for 3 monitor tests of 25 sows each during the 27 months of the project (5 hr labor × $6 = $30). Producers with PRV-free herds have an incentive to support an eradication program.

Seedstock producers NPV of physical losses due to pseudorabies outbreak is estimated to be $5.92 per sow if the first outbreak occurs 31.6 years from now and then every 63.2 years. The NPV of sales restriction of seedstock due to a 1-year quarantine is $87.56 per sow. Seedstock producers have sales restriction losses when their herds become pseudorabies positive even if they do not experience a clinical outbreak. Multiplying these NPV's of pseudorabies losses times a 60- or 100-sow herd makes it obvious why seedstock producers are such strong advocates of eradication.

Price discrimination against market hogs from pseudorabies infected herds was minimal. The cost during 1985 to WI producers to comply with the IL feeder pig law was 30 cents per pig for testing 128,331 pigs, which is equal to $38,499. Four to 5 hours of labor are required to properly clean and disinfect a truck after hauling pseudorabies infected hogs. A PA meat packer reported the prevalence of arthritis, pneumonia, and abscesses was higher in hogs from pseudorabies infected herds. This caused more trimming and a higher rate of condemnation and is an added direct cost of pseudorabies to farmers who sell on grade and yield.

REFERENCES


319


Table 1. Number of Pseudorabies-Infected Herds by Herd Size (1984–1985) Compared to 1982 Census of Agriculture Inventories, Illinois and Iowa Projects

<table>
<thead>
<tr>
<th>Herd size number of sows</th>
<th>Illinois Number of infected herds</th>
<th>Number of herds, census a</th>
<th>Iowa Number of infected herds</th>
<th>Number of herds, census b</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–24</td>
<td>6</td>
<td>412</td>
<td>1</td>
<td>85</td>
</tr>
<tr>
<td>25–49</td>
<td>7</td>
<td>211</td>
<td>2</td>
<td>65</td>
</tr>
<tr>
<td>50–99</td>
<td>6</td>
<td>193</td>
<td>11</td>
<td>66</td>
</tr>
<tr>
<td>100 +</td>
<td>14</td>
<td>169</td>
<td>23</td>
<td>42</td>
</tr>
<tr>
<td>FPF c</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

aMacoupin and Pike Counties
bMarshall County
cFPF = Feeder pig finishers, no sows on the farm
### Table 2. Pseudorabies Herd Infection Rates in the Pilot Project States, 1984

<table>
<thead>
<tr>
<th>Pilot project</th>
<th>Number of herds</th>
<th>Number of infected herds</th>
<th>Herd infection rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>174</td>
<td>32</td>
<td>18.4</td>
</tr>
<tr>
<td>Iowa</td>
<td>185</td>
<td>27</td>
<td>14.6&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>North Carolina</td>
<td></td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Pennsylvania&lt;sup&gt;b&lt;/sup&gt;</td>
<td>508</td>
<td>41</td>
<td>8.1</td>
</tr>
<tr>
<td>Wisconsin&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1,700</td>
<td>18</td>
<td>&lt;2.0</td>
</tr>
</tbody>
</table>

<sup>a</sup>14.6% is the herd infection prevalence rate on December 31, 1983. Herd infection rate is 18.1% when calculated by using 40 infected herds per 221 total herds tested.

<sup>b</sup>Lancaster County

<sup>c</sup>Lafayette, Green, Sauk, and Grant Counties

### Table 3. Percentage of Infected Herds Surveyed in the Economic Studies that Experienced Clinical Outbreaks of Pseudorabies, 1984 and 1985

<table>
<thead>
<tr>
<th>Pilot project</th>
<th>Number of infected herds</th>
<th>Number with clinical outbreaks</th>
<th>% clinical outbreaks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>32</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Iowa</td>
<td>40</td>
<td>17</td>
<td>42.5</td>
</tr>
<tr>
<td>North Carolina</td>
<td>15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8</td>
<td>53.3</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>41</td>
<td>24</td>
<td>58.5</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>27</td>
<td>6</td>
<td>22.2</td>
</tr>
</tbody>
</table>

<sup>a</sup>The 12 infected feeder pig finishing units surveyed are not included, 3 of which had clinical outbreaks.
## Table 4. Per Herd Cost to Producers Who Had Pseudorabies Outbreaks, 1984 & 1985

<table>
<thead>
<tr>
<th>Item of loss</th>
<th>Iowa</th>
<th>Pennsylvania</th>
<th>Wisconsin</th>
<th>Illinois</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursing pig mortality</td>
<td>1,920</td>
<td></td>
<td>395</td>
<td></td>
</tr>
<tr>
<td>Stillbirths</td>
<td>644</td>
<td></td>
<td>119</td>
<td></td>
</tr>
<tr>
<td>Infertility of sows</td>
<td>159</td>
<td>3,863</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td>Abortions</td>
<td>1,154</td>
<td></td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>Growing pig mortality</td>
<td>29</td>
<td></td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Backward pigs</td>
<td>33</td>
<td>270</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Loss of seedstock sales</td>
<td></td>
<td>4,002</td>
<td>848</td>
<td></td>
</tr>
<tr>
<td>Loss of feeder pig sales</td>
<td></td>
<td>4,132</td>
<td>673</td>
<td></td>
</tr>
<tr>
<td>Loss of other livestock</td>
<td></td>
<td>355</td>
<td>173</td>
<td></td>
</tr>
<tr>
<td><strong>Total cost per herd</strong></td>
<td>3,939</td>
<td>12,622</td>
<td>2,441</td>
<td></td>
</tr>
<tr>
<td><strong>Average herd size</strong></td>
<td>111</td>
<td>120</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td><strong>Average cost per sow</strong></td>
<td>35</td>
<td>105</td>
<td>33</td>
<td>138b</td>
</tr>
</tbody>
</table>

*aThe cost of the losses at farrowing and mortality of nursing and feeder pigs were lumped into a single figure for PA.

*bDetermined by a computer simulator model, not by survey of pilot project herds.
Table 5. Producer Cost Per Herd of Eradicating Pseudorabies in the Iowa Pilot Project, 1985

<table>
<thead>
<tr>
<th>Item</th>
<th>Test and removal&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Offspring segregation&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Depopulation/repopulation&lt;sup&gt;FF&lt;sup&gt;c&lt;/sup&gt;&lt;/sup&gt;</th>
<th>FPF&lt;sup&gt;d&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downtime</td>
<td>0</td>
<td>0</td>
<td>12,990</td>
<td>0</td>
</tr>
<tr>
<td>Depopulate</td>
<td>0</td>
<td>3,227</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cleanup</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td>0</td>
<td>89</td>
<td>1,200</td>
<td>6</td>
</tr>
<tr>
<td>Supplies</td>
<td>0</td>
<td>26</td>
<td>84</td>
<td>10</td>
</tr>
<tr>
<td>Segregating</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td>0</td>
<td>28</td>
<td>900</td>
<td>90</td>
</tr>
<tr>
<td>Facilities</td>
<td>0</td>
<td>0</td>
<td>1,324</td>
<td>400</td>
</tr>
<tr>
<td>Testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial herd test</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsequent</td>
<td>63</td>
<td>46</td>
<td>113</td>
<td>17</td>
</tr>
<tr>
<td>Loss selling “test and removal” positives</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Vaccination</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td>30</td>
<td>68</td>
<td>900</td>
<td>0</td>
</tr>
<tr>
<td>Cost/ herd</td>
<td>93</td>
<td>3,484</td>
<td>17,511</td>
<td>523</td>
</tr>
<tr>
<td>Cost/sow</td>
<td>1</td>
<td>29</td>
<td>146</td>
<td></td>
</tr>
<tr>
<td>Cost/pig</td>
<td></td>
<td></td>
<td></td>
<td>0.30</td>
</tr>
</tbody>
</table>

<sup>a</sup> Test and removal was used to clean up 5 breeding herds.

<sup>b</sup> Offspring segregation was used to clean up 14 breeding herds.

<sup>c</sup> FF = Farrow to finish. Depopulation was used to clean up 1 farrow to finish herd.

<sup>d</sup> FPF = Feeder pig finisher. Depopulation was used to clean up 3 feeder pig finisher herds.
Table 6. Producer Costs Per Herd of Eradicating Pseudorabies in the Pennsylvania, Wisconsin, and Illinois Projects Compared to Offspring Segregation Plan in Iowa, 1985

<table>
<thead>
<tr>
<th>Item</th>
<th>Pennsylvania</th>
<th>Wisconsin</th>
<th>Iowa</th>
<th>Illinois</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downtime</td>
<td>39,072</td>
<td>5,785</td>
<td></td>
<td>53,937</td>
</tr>
<tr>
<td>Depopulate</td>
<td>14,675</td>
<td>2,350</td>
<td>3,227</td>
<td></td>
</tr>
<tr>
<td>Cleanup</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td>975</td>
<td>136</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>Supplies</td>
<td>334</td>
<td>355</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Segregating</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td>18</td>
<td>526</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Facilities</td>
<td>522</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Testing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial herd test</td>
<td>45</td>
<td>37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsequent</td>
<td>42</td>
<td>63</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Loss selling “test and removal” positives</td>
<td>275</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaccination</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td></td>
<td></td>
<td></td>
<td>68</td>
</tr>
<tr>
<td>Total</td>
<td>55,161</td>
<td>10,049</td>
<td>3,484</td>
<td></td>
</tr>
</tbody>
</table>

Pennsylvania: Costs are for the depopulation method only. The average downtime was 7.4 months per herd, which is the reason for the high cost of downtime.

Wisconsin: Pseudorabies was eradicated in some herds by the depopulation method and in some by the test and removal method. The costs reported in this table are the average costs for both groups of herds.

Illinois: The depopulation cost was estimated for a 100-sow herd by using a simulation model, not from survey data of pilot project herds that had eradicated pseudorabies. The computer model calculated costs for depopulating and replacing the breeding herd with bred gilts and the cost of lost production (downtime). The calculated cost amounted to $53,937 per herd.

<table>
<thead>
<tr>
<th>Item of cost</th>
<th>Cost/sow/yr</th>
<th>Cost/herd/yr</th>
<th>Project cost, 27 mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative herds</td>
<td></td>
<td></td>
<td>$</td>
</tr>
<tr>
<td>Surveillance(^a)</td>
<td>1.73</td>
<td>174</td>
<td>61,534</td>
</tr>
<tr>
<td>Vaccination</td>
<td>1.50</td>
<td>91</td>
<td>31,672</td>
</tr>
<tr>
<td>Positive herds(^b)</td>
<td></td>
<td></td>
<td>$</td>
</tr>
<tr>
<td>Plan A</td>
<td>4.10</td>
<td>459</td>
<td>3,208</td>
</tr>
<tr>
<td>Plan B</td>
<td>11.67</td>
<td>1,686</td>
<td>86,092</td>
</tr>
<tr>
<td>Plan C</td>
<td>29.09</td>
<td>1,369</td>
<td>8,641</td>
</tr>
</tbody>
</table>

\(^a\)Surveillance includes blood collection and laboratory fees for serology.
\(^b\)Plan A = test and removal, Plan B = offspring segregation, and Plan C = depopulation/repopulation.
Table 8. Itemized Public Costs of Eradicating Pseudorabies in the Pilot Projects

<table>
<thead>
<tr>
<th>Item</th>
<th>Illinois*</th>
<th>Iowa*</th>
<th>North Carolina*</th>
<th>Pennsylvania*</th>
<th>Wisconsin*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory Technicians</td>
<td></td>
<td></td>
<td>$44,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testing</td>
<td>19,242</td>
<td>22,178</td>
<td>32,322</td>
<td>19,022</td>
<td></td>
</tr>
<tr>
<td>Overhead</td>
<td></td>
<td></td>
<td>70,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herd plan</td>
<td>51,810</td>
<td></td>
<td></td>
<td>23,515</td>
<td></td>
</tr>
<tr>
<td>Testing</td>
<td></td>
<td></td>
<td></td>
<td>3,165</td>
<td></td>
</tr>
<tr>
<td>Veterinarians</td>
<td>37,200</td>
<td>14,350</td>
<td>90,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technicians</td>
<td>1,650</td>
<td></td>
<td>54,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Veterinary pathologist</td>
<td></td>
<td></td>
<td>45,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries</td>
<td></td>
<td></td>
<td>246,270</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administrative not included</td>
<td>17,270</td>
<td></td>
<td>25,000</td>
<td>51,595</td>
<td></td>
</tr>
<tr>
<td>Support staff</td>
<td>35,910</td>
<td>29,616</td>
<td>30,000</td>
<td>17,616</td>
<td></td>
</tr>
<tr>
<td>Travel</td>
<td>30,080</td>
<td>6,739</td>
<td>53,031</td>
<td>13,500</td>
<td>845</td>
</tr>
<tr>
<td>Supplies</td>
<td>13,618</td>
<td>983</td>
<td>10,312</td>
<td>35,000</td>
<td></td>
</tr>
<tr>
<td>Fee basis testing</td>
<td>15,532</td>
<td>48,608</td>
<td>28,153</td>
<td>2,034</td>
<td></td>
</tr>
<tr>
<td>Vaccine</td>
<td>105,552</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indemnity</td>
<td></td>
<td></td>
<td></td>
<td>1,475</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>153,232</td>
<td>297,106</td>
<td>370,088</td>
<td>406,500</td>
<td>119,267</td>
</tr>
</tbody>
</table>

*aThe public costs for IL and IA are for 27 months of pilot project activity, July 1, 1983, to September 30, 1985.


The public costs for PA and WI are for 1 fiscal year, October 1, 1984, to September 30, 1985.
PSEUDORABIES

NATIONAL PSEUDORABIES ERADICATION COST ESTIMATES BASED ON DATA FROM THE FIVE PILOT PROJECTS BUDGET FOR TEN YEARS

I. Bases for estimation of prevalence of PR

B. Data from Iowa seroprevalence in finishing swine in infected herds = 61% seropositive. This figure is used in all calculations.
C. The 1982 swine population data from the Census of Agriculture.
   1. States with populations greater than or equal to 4,000,000 each: IL, IN, IA, MN, NE (5 States).
   2. States with 1,000,000 to 4,000,000 each: GA, KA, MI, MO, NC, OH, SD, WI (8 States).
   3. States with less than 1,000,000 each: Remaining 37 States.
D. The 1982 Census of Agriculture herd numbers × 74% to estimate the 1986 numbers = 244,200 total herds.
   1. For the 5 high population states: 90,200 herds.
   2. For the 8 middle population states: 70,000 herds.
   3. For the 37 low population states: 84,000 herds.

II. Bases for estimation of eradication costs

A. Estimated initial case finding costs, based on the pilot project.
   1. Area testing in high prevalence states (IL, IA): $642 per infected herd.
   2. Slaughter sampling of cull breeders (NC, PA, WI): $300 per infected herd.
B. Estimated producer costs per herd cleaned up, based on the pilot projects.
   1. Depopulation without repopulation: $500.
   2. Depopulation/Repopulation, feeder pig finishers: $2,500.
   3. Depopulation/Repopulation, Farrow to finish operations: $12,500.
   5. Offspring segregation with phased turnover of herd: $3,500.
C. Estimated monitoring costs of negative herds per year.
   1. Area testing per herd based on Iowa project: $66.00.
   2. Slaughter surveillance per herd based on NC, PA, and WI data: $5.77.
D. Program costs per infected herd during cleanup, Iowa pilot project.
REPORT OF THE COMMITTEE

1. Serum collections and shipment, serology: $325.
2. Herd plans, records, and computer analysis: $28.00.
E. Indemnity costs per herd required to depopulate (Illinois): $5,000.

III. Estimation of occurrence of PR at initiation and during eradication program
A. Number of PR infected herds at initiation of program: 23,247 total.
   1. In 5 high population states with 90,200 herds 10.9% positive/61% seroprevalence × 90,200 herds: 16,178 total.
   2. In 8 middle population states with 70,000 herds 4.6% positive/61% seroprevalence × 70,000 herds: 5,279 total.
   3. In 37 low population states with 84,000 herds 1.3% positive/61% seroprevalence × 84,000 herds: 1,790 total.
B. Expected 25% additional herd infections during program: 5,812.
   1. In 5 high population states: 16,178 × 25%: 4,045.
   2. In 8 middle population states: 5,279 × 25%: 1,320.
   3. In 37 low population states: 1,790 × 25%: 447.

IV. Estimation of 10 year program costs during eradication: $151,758,126
A. Initial case finding: $21,035,276.
   1. In 5 high population states using area testing 16,178 herds at $642 per infected herd: $10,386,276.
   2. In 8 middle population states, using slaughter sampling 5,279 herds at $3,000 per infected herd: $5,279,000.
   3. In 37 low population states, using slaughter sampling 1,790 herds at $3,000 per infected herd: $5,370,000.

b. Monitoring of herds for 9 years after initial testing: $64,876,000.
   1. Slaughter surveillance with no traceback of negatives (45 states with middle and low populations). 149,582 mean number of negative herds × $5.77 per herd × 9 = $7,767,793.
   2. Traceback of positive sera and testing of these herds: 1,767 herds × $5.77 per herd × 9 = $91,760.
   3. Area surveillance testing of initially negative herds (5 high population states): 80,088 mean number of negative herds × $66 per herd × 9 = $47,572,272.
C. Herd plans, records, computer: 244,000 herds × $28 per head × 9 = $61,488,000.

328
PSEUDORABIES

D. Indemnification of required depopulated herds: 3% of infected herds × 29,059 herds × 5,000 = 4,358,850.

V. Projection of methods of herd clean up to be followed for infected herds

A. In 13 middle and high population states: 26,822 herds: $88,647,700
   1. Depopulation without repopulation (3%): 805 herds × $500: 4,025,000
   2. Depopulation/Repopulation, farrow to finish operations (5%): 1,341 herds × $12,500: 16,762,500
   3. Depopulation/Repopulation, feeder pig operations (10%): 2,682 herds × $2,500: 6,705,000
   4. Test and removal (20%): 5,364 herds × $550: 2,950,200
   5. Offspring segregation (62%): 16,630 herds × $3,500: 58,205,000

B. In 37 low population states: 2,237 herds: $16,684,850
   1. Depopulation without repopulation (10%): 224 herds × $5,000: 1,120,000
   2. Depopulation/Repopulation, farrow to finish operations (50%): 1,118 herds × $12,500: 13,975,000
   3. Depopulation/Repopulation, feeder pig operations (10%): 224 herds × $2,500: 560,000
   4. Test and removal (20%): 447 herds × $550: 245,850
   5. Offspring segregation (10%): 224 herds × $3,500: 784,000

Estimated total clean up costs: $105,332,550
Total estimated 10 year budget: $257,090,676

RECOMMENDATIONS TO PORK INDUSTRY ON FUTURE COURSE WITH REGARD TO PSEUDORABIES

By Jury Panel at Industry-Wide Meeting Jan. 20–21, 1986, Peoria, IL
Final Report Feb. 26, 1986

Based on the conviction that (1) the technical knowledge is available to eradicate pseudorabies from the U.S. domestic swine population, (2) given the commitment and leadership of pork producers eradication is attainable, and (3) eradication is in the best interest of the swine industry, we recommend that the goal of the industry be pseudorabies eradication. This would be accomplished by a voluntary program of individual herd cleanup for a period of time, followed by a mandatory program based on surveillance to disclose all infected herds. It is further recommended:
REPORT OF THE COMMITTEE

INFORMATION AND EDUCATION

An industry-wide information and education program shall precede the voluntary phase of the program and continue throughout the effort. Overall responsibility for coordinating this uniform, consistent information effort shall be assigned to National Pork Producers Council, American Farm Bureau Federation and the purebred swine registries. Assistance in this effort will be sought from all other organizations, national and state, from all segments of the food animal industry. Specific assignments for information projects include:

1. Updating and distribution of pamphlets on epidemiology and guidelines for eliminating PRV from individual herds—LCI;
2. A summary of the pilot projects—APHIS;
3. A summary of the economic analyses of the pilot projects—APHIS;
4. A program to acquaint practicing veterinarians with new technology on diagnostic tests, vaccines and details for developing herd plans to eliminate the virus from individual herds—AASP.

LEGISLATIVE, FUNDING INITIATIVES

The National Pork Producers Council and the American Farm Bureau Federation and their state affiliates are urged to assume leadership of a unified industry effort to achieve the following:

1. Determination by the U.S. Congress that it shall be public policy to eradicate pseudorabies from the domestic swine population.
2. Secure funding in the 1987 federal budget for herd studies designed to perfect techniques for eliminating the virus from large herds and support of cooperative programs in states with control/eradication efforts.
3. Secure inclusion in the 1988 APHIS budget of funding for a surveillance program and for support of cooperative programs in states with control/eradication efforts.
4. Formation of state committees including all segments of the food animal industry in each state. Such committees to be charged with responsibility for leadership in obtaining funding, legislative authority and producer support for the eradication program.

DETAILS OF THE ERADICATION PROGRAM

Details of the eradication program are to be developed by an industry-wide task force assembled by Livestock Conservation Institute. A proposed program shall be available by Sept. 1, 1986, for consideration by industry groups during the winter of 1986–87. Key elements of the program would include:

1. The initial stages of the program would be voluntary, with assistance
PSEUDORABIES

provided to individual infected herd owners to eliminate the virus from their herds in the form of technical assistance, advice and testing.

2. New technology for testing of swine serums to be made available to accredited veterinarians to ensure widespread on-farm use of these tests in cleaning up infected herds.

3. Indemnities, if part of the eradication program, should be minimal. A referendum of producers shall be conducted if producer funding of indemnities is a part of the program.

4. Before implementation of the mandatory phase of the program in any state there must be sufficient support from the food animal industry in that state to enact necessary legislation.

5. If producers indicate commitment to continuation of the program following the voluntary phase, the mandatory phase would include surveillance to disclose all infected herds, either by slaughter testing, first-point testing or down-the-road herd testing, depending on the availability of new technology. Such a surveillance program is expected to involve testing of cull breeding stock and would require an effective identification system.

6. The program should be flexible, on a state-by-state basis, for areas within states and for individual herds to allow for differing conditions and situations. Both in the voluntary and the mandatory phases of the program, individual herd plans be developed for each infected herd based on the needs and the situation in that herd. Individual states would take part on the basis of cooperative arrangements with USDA-APHIS.

7. The preliminary goal shall be for eradication plans to be in place in all states by Jan. 1, 1989.

MEMBERS OF JURY PANEL

Approving the Final Report:
Phil E. Bradshaw, Griggsville, IL
   Representing Livestock Conservation Institute
Dr. Rodney G. Johnson, Morris, MN
   Representing American Association of Swine Practitioners
Rick Maloney, Peoria, IL
   Representing American Association of Swine Records
Richard P. Myers, Colchester, IL
   Representing American Farm Bureau Federation
Keith E. Myers, Grundy Center, IA
   Representing National Feeder Pig Marketing Association
Hilman Schroeder, Sauk City, WI
   Representing National Pork Producers Council
REPORT OF THE COMMITTEE

Dissenting from Final Report:
Greg G. Gilsdorf, Atkinson, NE
Representing Pork Action Group

ADVISORS TO JURY PANEL
Roger G. Gerrits, Beltsville, MD
Representing ARS-USDA
Dr. Charles L. Kanitz, West Lafayette, IN
Representing American Association of Veterinary Laboratory Diagnosticians
Dr. M. H. Lang, Des Moines, IA
Representing United States Animal Health Association
Dr. L. W. Schnurrenberger, Hyattsville, MD
Representing APHIS-USDA

USAHA PSEUDORABIES COMMITTEE
STATE STATUS REPORTS

Illinois—In the voluntary herd clean-up program of quarantined herds, since Jan. 1, 74 herds have been released from quarantine, 47 because they are out of business and 27 on the basis of initial tests; herd plans have been developed and are being implemented in 151 herds; 257 quarantined herds are not in the program. Ten herds in the program are larger than 500 sows, all using offspring segregation, final clean-up not achieved yet. Legislation for an eradication plan is being prepared for introduction next year. In many of the herds in the program there is a lot less virus than was the case a few years ago.

Indiana—A feeder pig control program similar to the Illinois plan is being proposed; 577 herds are under quarantine, 80 to 90% in a 9-county area. A high-risk feeder pig market has been proposed, for pigs from that area, with buyers limited to high-prevalence areas.

Nebraska—Regulations are being written to implement the new control act, with a hearing scheduled for this fall. Change of ownership testing will be required beginning Oct. 1, 1987. Feeder pig controls will be phased in. From Oct. 1, 1987 to Dec. 31, 1988, markets will pen separately those pigs from qualified free herds, controlled-vaccinated herd or PRV monitored herds (sow herd tested annually, maximum of 30 head) or pigs from which a sample have been tested negative. After Jan. 1, 1989 all feeder pigs must be from tested sow herds or tested negative within 30 days prior to sale. Use of vaccine will be restricted to prior approval by the state veterinarian. A total of 300 herds are under quarantine.

North Carolina—A feeder pig import law has been proposed, based on testing annually a maximum of 30 sows. The same testing requirement for all sow herds in the state has been proposed.

Georgia—There are 23 herds under quarantine.

Minnesota—A preliminary program of testing long-time quarantined
herds in the northern part of the state has been carried out. Of the 35 quarantined herds in that area, 17 cooperated in the program and 8 were negative on a statistical sample. Cost was about $6 per sow or about $180 per herd. A plan for the same program in the southern part of the state is being developed. There is interest in developing a free area in the north to meet Wisconsin and Illinois feeder pig import laws. A total of 328 herds are under quarantine.

**South Dakota**—Legislation is being sought declaring eradication as the goal. Funds are available for testing to clean up quarantined herds. About 59 herds are under quarantine.

**Wisconsin**—On July 1 feeder pig production herd testing requirements went into effect for imports. The state eradication program was slowed down in February by three outbreaks in two counties in the southwestern corner of the state. Those cases spread until 16 herds were infected, including four clinical cases in which cattle died. The contact herds were disclosed by testing in a two-mile area around each infected work and by a slaughter surveillance program. All but two of the newly infected herds are under herd plans. Backtag retention in the slaughter surveillance program has been 65 to 75%. The lag of 4 to 6 weeks between slaughter and contact with the owner of the positive samples is too long. A total of 43,500 samples have been tested in the program.

**Missouri**—There is more positive discussion of PRV than ever, involving expanded control, possible eradication. A state committee was formed 10 months ago. There are 48 quarantined herds, about half in two counties. Prevalence is low in the southern, feeder pig production area. More than 240 feeder pig production sow herds were tested with only two positive. Surveillance testing of cull sows is being started and the committee is discussing adjacent herd testing, herd clean-up, change of ownership testing and testing of imported feral swine. Nearly $400,000 has been requested from the state legislature.

**Michigan**—A total of 225–250 herds are under quarantine. Change of ownership testing is required and by the first of the year legislation is expected to fund slaughter surveillance.

**Pennsylvania**—The disease has been endemic in Lancaster county since 1980. A voluntary program reduced prevalence by '82 to fewer than 10 herds, but some producers chose not to clean up. They were given 8 months to clean up, but the state waited too long to tighten the screws. In '83 and '84 $50 million in federal indemnities was paid to poultry producers in Lancaster county as a result of the avian influenza outbreak. That resulted in hardening of producer attitudes toward voluntary clean-up. There are now 46 quarantined herds. During the last 6 months, the state has backed off from requiring that a herd plan be in place to permit marketing of slaughter hogs. An indemnity of $100 per breeding animal is being offered for depopulation within 8 months. Testing is being sub-
REPORT OF THE COMMITTEE

sidized. Advice offered by state veterinarian: “Be sure you have a commitment from the industry for eradication.”

Iowa—The final report for the Marshall county pilot project, with 233 herds: 43 were found to be infected, 31 in initial testing, 12 infected during the project and 2 reinfected after cleaning up. Nine herds are still infected, in two of which the virus is no longer circulating. Since 1972, the state has quarantined 4,740 herds. A survey of those herds has resulted in release of quarantine in 1,550, with about 1,000 still to be surveyed. One 1,000-plus sow herd outside the pilot area was cleaned up using offspring segregation.

Biologics companies reported on developments as follows:

**Agri-Tech**—Two new diagnostic tests have been licensed and are being used in diagnostic laboratories.

**Molecular Genetics**—Three new products have been submitted to USDA for licensing: 1) Lifestart, a monoclonal antibody for use in the face of an outbreak; 2) Breakstop, a subunit vaccine which provides protection with one dose, but boosters at 6-month intervals will be recommended in endemic areas, will not cause seroconversion on ELISA test; 3) Lookout, a diagnostic test kit which will differentiate between field infection and the subunit vaccine. The farmer’s wife, who can run an ELISA test to determine pregnancy, will be able to run this PRV test. The company will advocate putting the test in the hands of the person who stands to lose the most, the swine owner, so he can avoid buying infected animals. The company will propose official status for use of the test in diagnostic labs, but availability to those producers. The test is expected to be available in six months.

**Norden Laboratories**—Production cost of a subunit vaccine being developed by the company has been reduced to 60 cents, still not competitive with vaccines now on the market.

**TechAmerica**—Omnivac, a modified live virus which acts like a killed vaccine, is on the market. It results in a low antibody response based on the SN test. A new diagnostic test is expected to be available in ’87.

**Upjohn**—A new recombinant DNA vaccine will pioneer new procedures developed by USDA for bioengineered products. After publication of a notice in the Federal Register, field trials will be started. The vaccine will have two gene deletions, the Tk gene which is essential for the virus to replicate in the nervous system, and a gX gene which will mean that vaccinated pigs will not produce antibodies against that protein, providing a means of distinguishing a vaccine titer from a field strain titer. The vaccine is termed a “stabilized” vaccine which cannot revert to virulence. In company tests the vaccine has reduced shedding of virus by vaccinated-challenged pigs in comparison with other vaccines.

334
PSEUDORABIES

**Viral Antigens**—The latex agglutination test is on the market. It is picking up antibody response sooner after challenge than the SN test. Use of the test is controlled by state veterinarians and in three states—California, Idaho and Pennsylvania—use by practicing veterinarians has been approved.
THE ECONOMIC LOSSES DUE TO SELECTED FOODBORNE DISEASES

Tanya Roberts, Ph.D.*

The prevalence of some foodborne infectious diseases is thought to be increasing in developed countries. The reported incidence of salmonellosis has doubled in the United States in the last sixteen years to about 40,000 cases annually.¹ The Illinois milk outbreak caused salmonellosis in more than 16,000 people in the spring of 1985. Public health officials estimate that 2 million cases of salmonellosis may occur annually in the United States (Carter Center). Campylobacteriosis, a similar intestinal disease, has an estimated incidence of 2.1 million cases annually.

The causes of this increasing incidence of foodborne disease are diverse. Some of the contributing factors include the following. There is a greater concentration of animals in larger production units, which permits easier transmission of disease from one animal to the other. There is considerable geographic movement of animals and birds that can spread disease across the countryside. Today the use of improperly processed animal by-products and wastes in animal feeds can introduce and perpetuate disease cycles. Concentration of animal slaughter in fewer and larger plants increases the possibilities for cross-contamination between carcasses (Schwabe, pp. 552–53; Snoeyenbos). An increased number of distribution stages and eating away from home means more mass production of food and the greater inherent possibilities of improper heating and refrigeration—two of the most common contributors to foodborne disease in meat and poultry (Bryan). People are traveling more and eating more exotic foods and being exposed to a greater variety of foodborne hazards. Finally, the organisms themselves have been evolving. They are adapting to modern food processing and are more able to survive (Archer). Also, they are developing resistance to human drug therapies (Holmberg, et al.).

Methodology

Foodborne disease costs are just beginning to be evaluated. A consistent methodology is still being developed for evaluation of many components, such as the value of life and the value of discretionary time lost while ill. Here I examine partial costs for five foodborne diseases: salmonellosis, trichinosis, toxoplasmosis, campylobacteriosis and beef tapeworm. Individual's illness costs are estimated for medical expenses and lost productivity. A more complete accounting would also include the individual's

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¹ U.S. civilian population growth was less than 20% from 1986 to 1984.
LOSSES DUE TO FOODBORNE DISEASES

pain and suffering, discretionary time lost, averting behavior,\(^2\) industry costs, and public costs (table 1).

**Medial Costs of Illness**

(a) All diseases are typically underreported.\(^3\) Epidemiologists have found that only 1 in 75 salmonellosis cases are reported (Smith and Blaser, 1985). Rather than just rely on reported cases, estimates of the total U.S. incidence are used whenever possible.

(b) The severity of illnesses caused by the diseases considered here vary from essentially unnoticeable to life-threatening. The incidence and severity of illness depends upon the number of organisms or amount of toxin encountered and in what foods, the pathogenicity of the organism or toxin, and the strength of the individual’s immune system in defending against the pathogenic agents (figure 1). However, fatalities can occur in relatively normal human adult hosts (Smith and Blaser, 1985). Where possible, costs have been estimated for three disease severity levels—mild, moderate, and deadly. Mild cases represent a day or two of illness and moderate cases a week or two of illness.

(c) Secondary data sources are used to derive 1985 cost estimates. Often these costs are estimated from surveys of people involved in an outbreak of foodborne disease.

**Productivity Lost**

Days lost from work are the typical measure of lost productivity and this time is valued at the individual’s wage, or the average wage rate if the individual’s wage is unknown.\(^4\) The United States Department of Labor’s Bureau of Labor Statistics reports “average weekly earning of production or nonsupervisory workers on private nonagricultural payrolls.”

\(^2\)Averting behavior costs (behavior designed to avoid or reduce the risk of illness) can also be a significant cost item. A recent Resources for the Future study of the contamination of a water supply found the public will pursue a variety of measures to avoid illness—boiling water, travelling to another community to obtain water, and purchasing bottled water (Harrington, et. al., 1985).

Averting behavior by the public can result in diet and consumption expenditure changes that affect sales and revenues of the involved industry. An opinion survey by the National Pork Producers Council found that 40 percent of the surveyed consumers claimed that they had reduced their consumption of pork because of health concerns about salt and 17 percent claimed decreased poultry consumption because of disease concerns (Weise Research Associates, 1984). Of course, opinion surveys by themselves do not provide empirical evidence of actual reductions in consumption and impacts upon industry revenue.

\(^3\)Foodborne diseases are even more likely to be underreported because the reporting by physicians is voluntary, often the cases are mild and of limited duration so physicians may not be seen, the suspect food is seldom available to be tested for pathogens, and many foodborne pathogens have only recently been recognized and are not routinely tested (Archer, 1984, p. 321).

\(^4\)Some economists have also looked at reduced productivity while sick, but still reporting for work. Others have also attempted to make adjustments for heightened productivity when reporting back to work and attempting to catch up with the work backlog. Here these fine tunings are ignored and the average wage rate is used.
Evaluation of Death

Traditionally, deaths have been evaluated by the human capital method which measures the individual's contribution to productive output. The income stream that would have been produced by the individual is collapsed into a present value for that production at today's prices. The human capital method only places a value on what the individual produces for society. This will be used for the low estimate of the value of life.

From the perspective of the individual and consumer demand theory, a life ought to be valued by what the individual is willing to pay to avoid a particular risk of death. The individual's non-labor sources of income are included as resources to pay for risk reduction along with wages. Even more important are the nonmarket activities that may be of more value to the individual than his/her income lost (table 1). However, there are measurement problems with this method.

A hybrid approach attempts to bridge the gap between the two methodologies (Landefeld and Seskin, 1982). The adjusted willingness to pay/human capital approach includes only measurable economic losses associated with death (i.e., pain and suffering and lost leisure time are excluded). It is based on after-tax income from labor and nonlabor sources, discounts at the individual's rate of return after taxes, and includes risk aversion shown by investment in life insurance, security systems, etc. This will be the high estimate for the value of life.

The human capital and adjusted willingness to pay/human capital methods are age-specific and the values of life for death due to salmonellosis are $85,800 and $351,500 (1985 dollars), respectively (Morrison and Roberts, 1985, p. IV-10). The value of life for death due to helminthiases (trichinae and related worm-like parasites) is $140,000 and $471,000, respectively (Ibid., p. IV-15).

The Cost of Selected Foodborne Diseases

Medical costs and productivity losses caused by five foodborne diseases are estimated here. These diseases are salmonellosis and campylobacteriosis which cause intestinal disturbances, toxoplasmosis which can cause eye problems and mental retardation in fetuses, trichinosis which can cause a variety of ailments, and beef tapeworm which causes discomfort. The omission of other foodborne diseases does not mean they are trivial, only that they are not evaluated here.

Salmonellosis

Typically, Salmonella-caused disease is limited to salmonellosis, an acute gastroenteritis which appears 12 to 74 hours after eating contaminated food. Salmonellosis may cause only mild abdominal discomfort with minimal diarrhea lasting less than a day. More acute symptoms of disease include nausea, stomach ache, vomiting, diarrhea, cold chills, fever, and exhaustion. The symptoms of disease normally persist for 2 to 6
days, but in exceptional cases for several weeks. A small percentage (0.1 percent) of the people who contract salmonellosis die from it, and fatality is generally limited to the sick, those taking antibiotics, infants, or the elderly. However, in rare cases Salmonella, like some other bacterial and parasitic infections, can cause chronic disease syndromes (see Appendix).

“The enormous reservoir of contaminated food products, especially poultry products, has caused a steady increase in the incidence of salmonellosis” (Berkow, 1982, p. 103). The number of organisms needed to cause disease varies, but as few as 10 cells of Salmonella per gram or per milliliter in hamburgers and pasteurized milk have been sufficient (Mulder, 1982, p. 8). The Carter Center for CDC/Emory University estimates 2 million cases of salmonellosis occur in the United States each year (Holmberg, 1985). Foodborne sources account for 82 percent of the known causes (Cohen and Gangarosa, 1978).

The most extensive data on costs come from a CDC investigation of the Colorado outbreak (Cohen, et. al., 1978). The average survey respondent reported costs of $1,290 (in March 1985 $)—medical costs of $938, wage or productivity losses of $289 and miscellaneous costs of $62 (Roberts, 1985). The data from this outbreak are assumed to be representative of all cases reported to CDC. There are roughly 40,000 salmonellosis cases reported annually (Holmberg, 1985).

For those 2,000 salmonellosis patients who are estimated to die, the present value of life is estimated using the two methods discussed and result in values per life of $85,800-low estimate and $351,500-high estimate.

Mild cases of salmonellosis are the remainder of the estimated 2 million cases minus the 40,000 reported cases, or 1,960,000 cases. Costs are not well studied. Some of the unreported cases are as serious as the reported cases, but the bulk are probably much less severe. How much less severe is not known. The mild cases are assumed to have costs of $230 apiece (March 1985 $) which is what Cohen et. al. estimated for unreported case of salmonellosis in the Colorado outbreak.\(^5\)

The medical costs and lost productivity for foodborne salmonellosis in the United States total an estimated $553 to $988 million annually (table 2). Notice that medical costs are much smaller than the productivity losses.

**Campylobacteriosis**

Surveillance data for Campylobacter jejuni (C. jejuni) food poisoning is spotty, but all recent studies indicate it is more common than salmonellosis as a cause of intestinal flu-like disease. The Carter Center of CDC/  

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\(^5\) The $125 figure reported in the original article is updated using the change in the Consumer Price Index.
ROBERTS

Emory University estimates there are 2.1 million cases annually in the United States. A conservative measure of the costs of campylobacteriosis illness would be the salmonellosis costs for illnesses and deaths, given that the duration of the illness and likelihood of hospitalization were somewhat greater for campylobacteriosis in the Seattle study. Campylobacteriosis is generally self-limiting, although like salmonellosis more serious complications can occur, such as colitis, arthritis, and meningitis (Appendix).

Surveys in Denver and Seattle give us two estimates of the number of cases of moderate illness (Smith and Blaser, 1985; Seattle, 1984). Extrapolating to the United States, the Denver study suggests 57,340 moderate cases annually nationwide and the Seattle study suggests 168,025 moderate cases nationwide.

The mild cases are the residual between the 2.1 million annual cases of campylobacteriosis and the low and high estimate for the moderate cases. Like salmonellosis, the case-fatality rate is 1,000 to 1, for an estimated 2,100 fatalities a year.

The medical costs and productivity losses associated with campylobacteriosis are estimated at between $723 million to $1.4 billion annually (table 3). Again, the productivity costs are more important than medical costs.

Trichinosis

The decline in human cases of trichinosis has been dramatic in the U.S., while in Germany the disease has all but disappeared, largely because they inspect for it (Pawlowski, 1981). Trichinosis varies from asymptomatic illness to death depending largely on the numbers of live larvae ingested which have not been killed by cooking. After offspring are produced in the small intestine, they migrate throughout the body, lodge in the muscles, and may produce a wide variety of ailments. Consequently many cases of trichinosis are undiagnosed because they are so mild or misdiagnosed because of the diversity of symptoms (Zimmerman, Steele and Kagan, 1973). Autopsy data indicates there may be 100,000 exposures annually (Carter Center, 1985). Most of these cases are successfully fought off by the individual’s immune system without causing illness in the individual.

Reported cases of trichinosis averaged 152 human cases annually from 1975–81 (Schantz, 1983). To estimate the unreported cases, there is information from an outbreak occurring at sea. Three cases of trichinosis were reported while 10 other cases were found in the follow-up epidemiological investigation (Singal, Schantz, and Werner, 1976). If this outbreak is representative, then there are 3.3 unreported cases for each reported case of trichinosis (10/3). The estimated number of unreported cases of trichinosis is 502 annually (152 reported cases × 3.3). The total becomes an estimated 654 cases annually (152 reported + 502 unreported).
LOSSES DUE TO FOODBORNE DISEASES

Medical costs and lost wages were estimated for an outbreak of trichinosis affecting seventeen people in 1975 (Potter et al., 1976). In 1985 prices the per patient medical cost was $1,860 (Roberts, 1985). Multiplied times the estimated 654 cases resulted in $1.2 million medical cost per year for trichinosis. The wages lost averaged $625 in this outbreak, for a total of $.4 million.

Also, about one death a year is reported for trichinosis. I assume that deaths are underreported just like illnesses and that roughly four deaths a year occur. Evaluating these deaths with the two methods results in a range of $.5 to 1.9 million for the value of lives lost. This gives a total cost range for illness and deaths due to trichinosis of $2.2 to 3.5 million (table 4).

Toxoplasmosis

Another disease arising from consuming undercooked pork, or in rare instances handling of raw pork, is toxoplasmosis. There are only two environmental sources of infection—meat and ingesting soil contaminated with cat feces. Pork and mutton are commonly infected in the U.S. whereas beef or broilers are rarely infected (Ruiz and Frenkel, 1980). Dubey, et. al. (1979) report that several surveys show widespread, non-clinical infections with *Toxoplasma gondii* in U.S. pigs. There are no concrete numbers on the sources of human toxoplasmosis, but public health researchers suggest that pork causes half to three quarters of the U.S. cases. This conclusion was reached by surveying households with cats and taking blood samples to determine whether exposure had occurred. No systematic relationship was found. Instead a relationship was found between adults and exposure, which was attributed to the post-adolescent cultural habit of eating undercooked or raw meat.

If a pregnant woman becomes infected with toxoplasmosis there is a 20–40 percent probability her fetus will be infected. Surviving babies are likely to suffer eye damage and have a probability of mental retardation. An estimated 3,300 babies born every year in the U.S. are infected. Wilson and Remington conservatively estimated the life time cost for 3,300 children born with congenital toxoplasmosis in the U.S. every year was $430 million each year (updated to 1985 prices in table 5). Because babies born every year are exposed to the risk of toxoplasmosis, in a steady state with a constant number of births each year, the annual costs incurred

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6While death certificates list the cause of death, the variety of organs affected by trichinosis make the diagnosis difficult unless an autopsy is performed.

7Kenneth Walls, Protozoan Disease Branch, CDC suggested 50 percent and Jacob Frenkel, University of Kansas Medical Center, suggested 75 percent (personal communications, 1985). Also, Dubey, Murrell and Fayer report that “ingestion of cysts in undercooked pork infected with *Toxoplasma gondii* is thought to be a major source of *Toxoplasma* infection in human beings” (1984, p. 1941). They also report that *Toxoplasma gondii* can persist in the edible tissue of pigs until slaughter.
would be $430 million each year. Then, the cost of mental retardation and eye problems in babies due to the 50–75 percent of cases caused by pork is estimated at $215 to $323 million annually.\(^8\)

**Beef Tapeworm (Taenia saginata)**

Eating a larva that has not been killed by thorough cooking will infect a person. Unless medical treatment is provided, the mature tapeworm will live in the intestine until the death of the individual. Symptoms vary in their intensity and some persons never realize they have a tapeworm. However most people experience symptoms which "... may include nervousness, insomnia, anorexia, loss of weight, abdominal pain, and digestive disturbances" (Benenson, 1975, p. 319). Occasionally, other organs are invaded and serious disorders can occur (Hubbert, McCullock, and Schnurrenberger, 1975, p. 679).

The Carter Center of CDC/Emory University estimates that 1,000 tapeworm cases occur annually in the U.S. Typically the disease symptoms are mild. The cost to remove a tapeworm involves two visits to a doctor, a stool examination, and drug treatment (Roberts, 1983, p. 34). These medical costs and time-off work for the visits to the doctor are estimated at $111 per case (Morrison and Roberts, 1985). The annual cost due to the beef tapeworm, *Taenia saginata*, is conservatively estimated at $.1 million.

**Disease Cost Summary**

The medical costs and productivity losses for five foodborne diseases associated with raw chicken, pork and beef are estimated to total between 1.5 and 2.7 billion dollars annually in the United States (table 6). Trichinosis and beef tapeworm are relatively minor hazards, but salmonellosis, campylobacteriosis and congenital toxoplasmosis all have impacts in the hundreds of millions of dollars each year. Lost productivity is the greatest cost component, significantly outweighing medical costs. However, these cost estimates omit the chronic complications that can result from all five diseases, ranging from arthritis to blood poisoning to heart disease (Appendix). Also omitted are lost leisure time, travel costs, and averting behavior costs—which could be important for trichinosis, in that people

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\(^8\)An estimated 2.3 million cases of toxoplasmosis occur in adults annually. Most cases are mild and fought off by the individual's immune system. However, toxoplasmosis can cause three types of disease syndromes in adults. A common infection of the lymph system; the occasional, more severe infection of the lymph system plus another organ such as the brain, heart, lung, liver or skeletal muscles; and finally a rare life threatening, generalized toxoplasmosis which is usually associated with immunological deficiency.

Once exposed to toxoplasmosis, the individual is likely to be left with cysts embedded in tissue for the rest of his/her life. If the individual's immune system fails because of old age, immunosuppressive diseases such as AIDS or cancer, immunosuppressive drugs, or if the cysts are mechanically broken, an acute phase of the infection begins again (Fayer and Dubey, 1985, p. 57).

The benefit of preventing these adult cases is likely to be substantial, but not quantified at this time.
may either overcook the meat or avoid it altogether. Pain and suffering are underestimated or omitted for the ill person and other family members and friends.

These estimates also exclude the impact on industry at both the farm level and the retail level. German researchers have estimated that the costs of reduced output try is greater than the human illness costs (Krug). Todd found the food processor's or restaurant's costs associated with an outbreak and the ensuing reduction in demand, product recall, plant closings, and product liability suits may be as significant as the human illness costs. For salmonellosis, the estimates presented here exclude the possibilities of cross contamination from chicken and beef to other cooked or raw foods (Bryan, Ayers, and Kraft).
Figure 1. Direct and Indirect Foodborne Illness Costs

A market purchase of raw or prepared food

Exposure to possible foodborne illness

Incidence and severity of illness

Direct costs imposed on the ill person and the firm in the market transaction

Monetizable costs

Nonmonetizable costs

Indirect costs imposed on others outside the market transaction

Monetizable costs

Nonmonetizable costs
**Table 1. Social Costs of Foodborne Illness**

<table>
<thead>
<tr>
<th>Costs to Individuals</th>
<th>Industry Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Costs</td>
<td>Product recall</td>
</tr>
<tr>
<td>Income or productivity loss</td>
<td>Plant closing and cleanup</td>
</tr>
<tr>
<td>Pain and suffering</td>
<td>Product liability costs*</td>
</tr>
<tr>
<td>Leisure time lost</td>
<td>Reduced product demand</td>
</tr>
<tr>
<td>Averting behavior costs</td>
<td>Public Health Surveillance Costs</td>
</tr>
<tr>
<td>Risk aversion costs</td>
<td>Costs of maintaining disease surveillance</td>
</tr>
<tr>
<td>Child care costs</td>
<td>Costs of investigating outbreak</td>
</tr>
<tr>
<td>Travel costs</td>
<td>Costs of cleanup</td>
</tr>
</tbody>
</table>

*In adding up costs, care must be taken to assure that product liability costs to firms are not already counted in the estimated pain and suffering cost to individuals. Recent controversy over the size of liability claims has caused many states and the U.S. Congress to consider limiting liability for noneconomic damages to $100,000 per person.

**Table 2. Cost of Foodborne Salmonellosis, U.S., 1985 dollars**

<table>
<thead>
<tr>
<th>Cost Categories</th>
<th>Costs per case</th>
<th>Cases</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dollars</td>
<td></td>
<td>million dollars</td>
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<tr>
<td><strong>Medical Costs</strong></td>
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<td></td>
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<tr>
<td>Mild cases</td>
<td>0</td>
<td>1,960,000</td>
<td>0</td>
</tr>
<tr>
<td>Moderate cases and death</td>
<td>938</td>
<td>40,000</td>
<td>37.5</td>
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<tr>
<td><strong>Lost Productivity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild cases</td>
<td>230b</td>
<td>1,960,000</td>
<td>450.8</td>
</tr>
<tr>
<td>Moderate cases</td>
<td>289c</td>
<td>38,000</td>
<td>11.0</td>
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<tr>
<td>Deaths:</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Human capital method</td>
<td>85,800</td>
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<td>171.6</td>
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<tr>
<td>or Adjusted human capital/willingness to pay method</td>
<td>351,500</td>
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<td>703.0</td>
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<tr>
<td><strong>Miscellaneous costs</strong></td>
<td>62</td>
<td>40,000</td>
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<tr>
<td>Total</td>
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<td>$673 to $1,205 million</td>
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<tr>
<td>Foodborne sources</td>
<td></td>
<td></td>
<td>$553 to $988 million</td>
</tr>
</tbody>
</table>

*a Miscellaneous costs include transportation, child care, other laboratory tests, finding new jobs.

*b This productivity loss estimate for mild cases also includes some miscellaneous costs of undetermined amount.

*c This is a low estimate because it leaves out the value of homemaking.
Table 3. Costs of Foodborne Campylobacteriosis, U.S., 1985 dollars

<table>
<thead>
<tr>
<th>Cost Categories</th>
<th>Costs per case</th>
<th>Cases</th>
<th>Total Estimate</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td></td>
<td>dollars number million dollars</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Medical Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild cases</td>
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<td>2,042,660</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>or</td>
<td>1,931,975</td>
<td></td>
</tr>
<tr>
<td>Moderate cases and deaths</td>
<td>938</td>
<td>57,340</td>
<td>53.8</td>
<td>157.6</td>
<td></td>
</tr>
<tr>
<td><strong>Lost Productivity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild cases</td>
<td>230b</td>
<td>2,042,660</td>
<td>469.8</td>
<td>444.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>or</td>
<td>1,931,975</td>
<td></td>
</tr>
<tr>
<td>Moderate cases</td>
<td>289c</td>
<td>55,340</td>
<td>16.0</td>
<td>48.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>or</td>
<td>166,025</td>
<td></td>
</tr>
<tr>
<td>Deaths:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human capital method</td>
<td>85,800</td>
<td>2,100</td>
<td>180.2</td>
<td>738.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>or</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted human capital/</td>
<td>351,500</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>willingness to pay method</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Miscellaneous</strong></td>
<td>62</td>
<td>57,340</td>
<td>3.6</td>
<td>10.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>or</td>
<td>168,025</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>$723 to $1,399 million</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*a* Miscellaneous costs include transportation, child care, other laboratory tests, finding new jobs.

*b* This productivity loss estimate for mild cases also includes some miscellaneous costs of undetermined amount.

*c* This is a low estimate because it leaves out the value of homemaking.

*d* Assumes all campylobacteriosis is of foodborne origin.
### Table 4. Cost of Foodborne Trichinosis, United States, 1985 dollars

<table>
<thead>
<tr>
<th>Categories</th>
<th>Cost per case</th>
<th>Cases</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Costs</td>
<td>1,864 dollars</td>
<td>654</td>
<td>1,216 thousand dollars</td>
</tr>
<tr>
<td>Productivity losses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>moderate cases</td>
<td>625 dollars</td>
<td>654</td>
<td>409 thousand dollars</td>
</tr>
<tr>
<td>deaths</td>
<td>140,000 or 471,000</td>
<td>4</td>
<td>560 or 1,884 thousand dollars</td>
</tr>
</tbody>
</table>

Total $2.2 \text{ to } 3.5 \text{ million}$

### Table 5. Lifetime Cost for Special Services for 3,300 Children with Congenital Toxoplasmosis Born in the United States Each Year, 1985 dollars*

<table>
<thead>
<tr>
<th>Service Required</th>
<th>Utilization</th>
<th>Cost of Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly ophthalmologic follow-up care</td>
<td>78.0%</td>
<td>4 million dollars</td>
</tr>
<tr>
<td>Special schooling for visually handicapped</td>
<td>14.2%</td>
<td>68 million dollars</td>
</tr>
<tr>
<td>Special schooling for moderately retarded</td>
<td>7.1%</td>
<td>23 million dollars</td>
</tr>
<tr>
<td>Institutional or state-supported foster care for severely retarded</td>
<td>15.1%</td>
<td>301 million dollars</td>
</tr>
<tr>
<td>Aid to totally disabled</td>
<td>2.4%</td>
<td>33 million dollars</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$430 million*</td>
</tr>
</tbody>
</table>

*This estimate is conservative because it does not include pain and suffering for the babies born with a mental or visual handicap and the suffering of the parents of these babies or the 15 percent who died. In addition, the survivors' medical complications have been underestimated and no adjustment has been made for reduced earning capacity caused by toxoplasmosis. Finally, the income losses due to parents caring for the child instead of working are not included.

Table 6. Medical Costs and Productivity Lost due to Selected Foodborne Diseases, United States, 1985 dollars

<table>
<thead>
<tr>
<th>Foodborne Disease</th>
<th>Cost Estimates</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>low</td>
<td>high</td>
<td></td>
</tr>
<tr>
<td></td>
<td>million dollars</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salmonellosis</td>
<td>553</td>
<td>988</td>
<td></td>
</tr>
<tr>
<td>Campylobacteriosis</td>
<td>723</td>
<td>1,399</td>
<td></td>
</tr>
<tr>
<td>Trichinosis</td>
<td>2.2</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>Congenital toxoplasmosis</td>
<td>215</td>
<td>323</td>
<td></td>
</tr>
<tr>
<td>Beef tapeworm</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,493</td>
<td>2,714</td>
<td></td>
</tr>
</tbody>
</table>

Assuming that 100% of the cases of trichinosis, beef tapeworm, and campylobacteriosis have foodborne sources. Salmonellosis is based on 82% of cases from foodborne sources while congenital toxoplasmosis is based on 1/2 (low estimate) to 3/4 (high estimate) of cases from foodborne sources.

Appendix. Complications Observed After Bacterial and Parasitic Infections Transmitted by Foods

<table>
<thead>
<tr>
<th>Infection</th>
<th>Complication Caused</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterial infections:</td>
<td></td>
</tr>
<tr>
<td>Salmonellosis</td>
<td>cholecystitis, colitis, endocarditis, meningitis, thyroiditis, myocarditis, rheumatoid syndromes, Reiter's disease, splenic abscesses, septicaemia, pancreatitis, osteomyelitis, aortitis</td>
</tr>
<tr>
<td>Campylobacteriosis</td>
<td>cholecystitis, colitis, endocarditis, meningitis, arthritis, carditis, septicaemia, erythema nodosum</td>
</tr>
<tr>
<td>Parasitic infections:</td>
<td></td>
</tr>
<tr>
<td>Taeniasis</td>
<td>arthritis</td>
</tr>
<tr>
<td>Toxoplasmosis</td>
<td>pancarditis, central nervous system disease</td>
</tr>
<tr>
<td>Trichinosis</td>
<td>neurological sequelae, cardiac dysfunction</td>
</tr>
</tbody>
</table>

Source: Mossel, 1984, p. 93.
Present Value of Life for Salmonellosis Fatalities, 1985

<table>
<thead>
<tr>
<th>Method</th>
<th>Age</th>
<th>Male</th>
<th></th>
<th>Female</th>
<th></th>
<th></th>
<th>Average</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Deaths</td>
<td>Present Value</td>
<td>Total Value</td>
<td>Deaths</td>
<td>Present Value</td>
<td>Total Value</td>
<td>Value</td>
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<td></td>
<td></td>
<td>number</td>
<td>thousand</td>
<td>dollars</td>
<td>number</td>
<td>thousand</td>
<td>dollars</td>
<td>3</td>
</tr>
<tr>
<td>Human Capital(^1)</td>
<td></td>
<td>0-4</td>
<td>3</td>
<td>88</td>
<td>264</td>
<td>4</td>
<td>77</td>
<td>307</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5-14</td>
<td>0</td>
<td>159</td>
<td>0</td>
<td>2</td>
<td>139</td>
<td>278</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15-24</td>
<td>2</td>
<td>300</td>
<td>600</td>
<td>1</td>
<td>241</td>
<td>241</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25-44</td>
<td>0</td>
<td>371</td>
<td>0</td>
<td>4</td>
<td>238</td>
<td>954</td>
</tr>
<tr>
<td></td>
<td></td>
<td>45-64</td>
<td>10</td>
<td>189</td>
<td>1,890</td>
<td>6</td>
<td>144</td>
<td>867</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65+</td>
<td>20</td>
<td>14</td>
<td>271</td>
<td>27</td>
<td>41</td>
<td>1,107</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>35</td>
<td></td>
<td>3,025</td>
<td>44</td>
<td></td>
<td>3,754</td>
</tr>
<tr>
<td>Adjusted willingness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to pay/human capital(^2)</td>
<td></td>
<td>0-4</td>
<td>3</td>
<td>1,208</td>
<td>3,624</td>
<td>4</td>
<td>836</td>
<td>3,102</td>
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<td>0</td>
<td>1,408</td>
<td>0</td>
<td>2</td>
<td>961</td>
<td>1,922</td>
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<tr>
<td></td>
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<td>15-24</td>
<td>2</td>
<td>1,655</td>
<td>3,309</td>
<td>1</td>
<td>1,086</td>
<td>1,086</td>
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<td>25-44</td>
<td>0</td>
<td>1,432</td>
<td>0</td>
<td>4</td>
<td>866</td>
<td>3,462</td>
</tr>
<tr>
<td></td>
<td></td>
<td>45-64</td>
<td>10</td>
<td>548</td>
<td>5,480</td>
<td>6</td>
<td>410</td>
<td>2,459</td>
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<tr>
<td></td>
<td></td>
<td>65+</td>
<td>20</td>
<td>34</td>
<td>680</td>
<td>27</td>
<td>90</td>
<td>2,443</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>35</td>
<td></td>
<td>13,091</td>
<td>44</td>
<td></td>
<td>14,675</td>
</tr>
</tbody>
</table>

2 Data from Landefeld and Seskin, 1982; Vital, 1984; Updated to March 1985 dollars.
3 Value calculated by dividing the total values for male and female by total number of deaths.
### Present Value of Life for Deaths Caused by Helminthiases

<table>
<thead>
<tr>
<th>Method</th>
<th>Age</th>
<th>Male</th>
<th>Female</th>
<th>Average Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Deaths</td>
<td>Present Value</td>
<td>Sum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>number</td>
<td>thousand</td>
<td>dollars</td>
</tr>
<tr>
<td>Human Capital&lt;sup&gt;1&lt;/sup&gt;</td>
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<td>0-4</td>
<td>0</td>
<td>87</td>
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<tr>
<td></td>
<td></td>
<td>5-14</td>
<td>0</td>
<td>158</td>
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<td></td>
<td>15-24</td>
<td>0</td>
<td>299</td>
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<tr>
<td></td>
<td></td>
<td>25-44</td>
<td>4</td>
<td>369</td>
</tr>
<tr>
<td></td>
<td></td>
<td>45-64</td>
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<td>8</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted human capital/willingness to pay&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td>0-4</td>
<td>0</td>
<td>1,202</td>
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<td></td>
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<td>1,646</td>
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<td>65+</td>
<td>8</td>
<td>32</td>
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<tr>
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<td></td>
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</tbody>
</table>

<sup>1</sup> Data from Dolan, et al, 1980; Vital, 1984; Updated to February 1985 dollars.

<sup>2</sup> Data from Landefeld and Seskin, 1982; Vital, 1984; Updated to February 1985 dollars.

<sup>3</sup> Value calculated by dividing the total values for male and female by total number of deaths.
REFERENCES


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Holmberg, Scott D. (1985) Enteric Diseases Branch, Div. of Bacterial Disease, CDC, letter to Tanya Roberts, April 24.


LOSER DUE TO FOODBORNE DISEASES


EMERGING MEAT/POULTRY-BORNE PATHOGENS
Dr. Brij N. Bhargava

Consumers spend roughly $300 billion for food each year. Thirty percent of this covers on-farm production, and 70% is for processing, transporting, and marketing of foods. This vast supply of food moves through about 25,000 food manufacturers, 35,000 wholesalers, 250,000 food stores, and 275,000 eating establishments. Add to this the number of homes in the country and you start to see the many possibilities in the food system that can give bacteria of various types the opportunity to create foodborne disease problems.

Most foods as raw materials are biological in nature and contain nutrients important to properly nourish consumers. However, foods also contain enzymes and are naturally contaminated by microorganisms. Unless these enzymes and microorganisms are destroyed or conditions are set up to prevent enzyme activity or microorganism growth, the food will spoil. Scientific knowledge of the relationship of microorganisms and their toxins to safety is growing at a tremendous rate, so we must face problems that we are just beginning to notice. With some of the tools available in our laboratories today, we can routinely find microorganisms and their toxins that were either impossible to detect or unknown 10 or 20 years ago. Technological developments create new problems continually in the area of microbial food safety. In many instances, these are not truly new. It is our recognition of the problem that is new; the unrecognized problem often has existed for decades. Emerging pathogens are not a static issue. Rather it is an ever-changing one and one that requires us not only to be knowledgeable about newly perceived threats to food safety but to develop measures to control. The year 1985 has been one of high concern because of the massive outbreak of salmonellosis from pasteurized milk and more than 90 deaths from listeria monocytogenes in soft cheese.

Foodborne disease outbreaks reported to the Centers for Disease Control (CDC) over a 5-year period were as follows:

<table>
<thead>
<tr>
<th>Place</th>
<th>No. of Outbreaks</th>
<th>% of Known Places</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Service Establishments</td>
<td>1,285</td>
<td>77</td>
</tr>
<tr>
<td>Homes</td>
<td>327</td>
<td>20</td>
</tr>
<tr>
<td>Food Processing Plants</td>
<td>52</td>
<td>3</td>
</tr>
<tr>
<td>Other/Unknown</td>
<td>615</td>
<td>—</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,279</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

EMERGING MEAT/POULTRY-BORNE PATHOGENS

There are several areas of microbial food safety that have received intense recent attention. These require that we accelerate our efforts to reduce undesirable microbes or their toxins in the food supply. In addition to their recent emphasis, these areas represent risks that are new or relatively new when measured in terms of this century. The Center for Disease Control continues to indicate that approximately 66% of illness outbreaks do not identify the causative agent. It is likely that new emerging technology and knowledge will reduce this unknown cause figure.

Persistent concerns: For decades, four microbes have been responsible for the majority of cases of foodborne infections or intoxications. These are Salmonella, Staphylococcus aureus, Clostridium perfringens, and Clostridium botulinum. They continue to cause the majority of foodborne problems or concerns even though they are easily controlled. Three of these, S. aureus, C. perfringens, and C. botulinum produce illness by producing toxins. In order to produce these toxins, they must multiply to enormous numbers in food products. Proper storage of food under refrigeration, particularly after cooking, is a simple, effective control measure. Because these three toxin producers are common in the food environment, gross failures of refrigeration are likely to result in problems. The numbers of persons affected will be proportional to the volume of food improperly held. In a home, the number is low, but if the fault occurs at the food processor or food service area, larger numbers of consumers can be made ill. C. botulinum has always been a great concern in the food safety area, not so much because of the numbers of cases involved but because of its lethal toxin. C. botulinum has been stereotyped in the past as a microorganism that cannot grow in the presence of oxygen, and has thus been associated primarily with improperly canned food. Research studies and botulism outbreaks during recent years serve to alert us that C. botulinum can grow and produce its toxin in a variety of food products exposed to air, including fresh mushrooms, boiled eggs, pot pies, baked potatoes, and sauteed onions. Salmonella differs from the others in that it is infectious rather than toxigenic. Accordingly, a low number of cells can under certain conditions, cause illness. Salmonella, Staphylococcus aureus and Clostridium perfringens are reported annually as the major causes of foodborne infections or intoxications and it is not likely that this will change in the near future.

Emerging pathogens: A group of bacteria is being heavily researched and watched concerning their need for control. Most of these are readily destroyed by pasteurization and are enteric in nature. Campylobacter species, particularly jejuni, is now believed by national and international health organizations to cause more cases of human enteric illness than Salmonella. The human illness is generally milder than that caused by Salmonella, but the organism is also more prevalent in the environment.
The disease known as campylobacteriosis or campylobacter enteritis, is more common in the U.S. than salmonellosis and shigellosis combined. Symptoms range from a brief insignificant enteritis to a severe case of enterocolitis, sometimes with apparent recovery followed by relapse. Extra-intestinal complications such as meningitis, cholecystitis, urinary tract infection, and reactive arthritis are not uncommon. Gastrointestinal symptoms and signs include nausea, abdominal cramps, headache, sometimes fever, and diarrhea, which may be bloody if severe. Onset time usually is 2–5 days. Duration usually is 2–3 days, but it can be weeks or months with complications. Death is rare.

The organism *C. jejuni* is a common inhabitant of the intestinal tract of cattle, swine, sheep, chickens, turkeys, dogs, cats, rodents, and monkeys.

It is particularly prevalent in wild birds and poultry. Research is underway in a number of universities and governmental agencies to determine whether certain strains are more invasive than others.

Numbers in excess of 1,000,000 organisms per gram of chicken or turkey feces is common. Thus, raw or inadequately cooked foods of animal origin are the most likely sources of human infection (e.g., raw milk, undercooked chicken, raw hamburger, raw shellfish). Unchlorinated water supplies have been the vehicle in several major outbreaks. The organism is unlikely to grow or even survive well in foods. It is easily killed by heat, is inhibited by acid, salt, and drying, and will not multiply at temperatures below 85°F.

**O Yersinia species:** Yersinia species are extremely common in nature. Some strains of *Yersinia enterocolitica* cause enteric illness in man and are invasive.

The infection caused by *Yersinia Enterocolitica* is known as yersiniosis. The most common form is gastroenteritis. More serious syndromes include mesenteric lymphadenitis, terminal ileitis, polyarthritis, erythema nodosum, septicemia, and meningitis. Fatality from gastroenteritis is rare, and recovery is generally complete within 1–2 days. Although the organism has been considered an “emerging pathogen” for a number of years, there have been relatively few confirmed outbreaks in the U.S.

*Y. enterocolitica* is commonly isolated from a wide variety of animals, food, and water sources. Pigs are the most important animal source. Foods include raw milk, meat, poultry, shellfish, and vegetables. Certain isolates (strains) produce disease, whereas others are of no public health concern. The organism is capable of growth at refrigeration temperatures. It is quite sensitive to heat and would be destroyed by adequate cooking of most foods and by pasteurization of milk.

**Escherichia coli:** This organism is a normal inhabitant of the intestinal tract and occurs in fecal material at levels of millions per gram. It was long considered harmless to health and was used simply as an indicator of fecal contamination in food and water.
EMERGING MEAT/POULTRY-BORNE PATHOGENS

**E. coli 0157H7:** The CDC has identified this microorganism as the causative agent of haemorrhagic colitis, a very serious enteric disease of humans.

The hemorrahagic colitis, or bloody diarrhea, this infection usually is characterized by severe abdominal cramps followed by watery, then grossly bloody stools. Onset time is usually 3–4 days; duration 2–9 days. Vomiting is common, but fever is rare. Diarrheal illness sometimes is followed by hemolytic uremic syndrome (HUS), a serious disease of the urinary tract characterized by kidney dysfunction with urea in the blood. HUS is a leading cause of acute kidney failure in children.

This strain of *E. Coli* has been found once in uncooked ground beef. The method for isolation and identification of this serotype of *E. coli* from foods has not been good enough to study the degree of food involvement. We must conclude that this strain of *E. coli* may have some food involvement and that it has invasive and cytotoxic capacities resulting in serious human illnesses.

**O Enterotoxigenic E. coli 027:H20:** This organism reached the U.S. in French-made Brie cheese. In September 1983, gastrointestinal illness was associated with eating a single lot of imported Brie cheese in Washington, D.C. Similar outbreaks followed in Colorado, Georgia, Illinois, and Wisconsin, all tied to soft cheese from the same factory in France. The identical serotype of *E. coli* was involved in all cases.

Meanwhile, in late 1983, several hundred people in the Netherlands became ill after eating Brie cheese manufactured in the same factory in France.

**O Afromonas species:** Species of the genus *Afromonas* have long been recognized as pathogens in fish and amphibians. During the past decade, some of the *Afromonas* species have been associated with human pathogenicity. At this time, two species, *A. Hydrophilia* and *A. sobria*, are on the verge of being considered causative agents of human gastroenteritis and could potentially be foodborne pathogens of major safety significance. They are invasive, produce enterotoxins, and are common to domesticated animals and their environment. Again, these are sensitive to usual cooking procedures.

**O Listeria monocytogenes:** Since 1981, cole slaw, milk and soft cheese have caused outbreaks of food infections, thus, we must now recognize that this can be a foodborne problem. While it has not been implicated in illnesses from meat and poultry products, it is a common contaminant of farm environments and has a long history of pathogenesis in a wide variety of mammalian species. While we have not looked for it in meat and poultry products yet, it’s probably present and needs more attention. It has a tolerance to salt, nitrite, and is somewhat more heat resistant than *Salmonella.*
The disease caused by *Listeria Monocytogenes* is known as listeriosis. Its primary manifestations are meningitis, abortion, and perinatal septicemia. Without therapeutic intervention, death usually results from listeric meningitis. Listeric abortion generally occurs in the last half of pregnancy and results in the delivery of stillborne or acutely ill infants. If borne alive, infants often die within a few minutes or hours after delivery. If infants survive, meningitis usually develops. This generally terminates in death or leads to permanent mental deficiency. As this would suggest, listeric infections are most frequently associated with pregnant women and newborns. Also at great risk are individuals with underlying diseases, such as malignancy, cirrhosis, or immune-deficiency states. The mortality rate in diagnosed cases is 20–35%, but it is likely that this figure is skewed. It seems probable that in health (not high-risk) individuals, self-limiting infection occurs and goes undiagnosed as listeriosis.

The organism is widely distributed in nature. It has been isolated from the feces of healthy human carriers as well as animals. It has been detected in normal and mastitic cow’s milk (and human milk). It has also been isolated from improperly fermented silage, leafy vegetables, and soil. It survives longer in sewage and sludge than does *Salmonella*. The organism is capable of growth at refrigeration temperatures. It is quite sensitive to heat and would be destroyed by adequate cooking of most foods and by pasteurization of milk. *L. monocytogenes* survives for long periods in soil, silage, feces, and milk. Its survival rate being greater than for most other foodborne pathogens.

**Salmonella:** Two clinical entities caused by *salmonella* are recognized: the food poisoning syndrome and enteric fever. In both of these, the organisms enter the body via the fecal-oral route. In the food-poisoning syndrome, the organisms multiply in the intestinal tract, producing symptoms which include diarrhea, cramping, and vomiting, usually with elevated temperature. In most cases, the illness is of relatively short duration and the mortality rate is low. Those at greatest risk are the very young, the aged, and the infirm. It is among these groups that the highest rates of morbidity and mortality occur. In the enteric fever syndrome, the organisms are carried from the intestinal tract to other parts of the body via the blood or lymphatic system. Ultimately, the salmonellae produce localized infections, including pneumonia and meningitis. The death rate from enteric fever is high. There are around 2,000 different *Salmonella* serotypes. Among these are some that are most likely to cause enteric fever. *S. typhi* is the classical agent in enteric fever, but any of the salmonellae are potentially capable of producing this disease syndrome. Aside from the immediate effects of *Salmonella* infection, recent findings indicate that serious chronic diseases may occur as sequelae. Among these are several rheumatoid disorders, in some cases with cardiac involvement. These serious sequelae to *Salmonella* infection have been only recently recognized. They are limited to *Salmonella* infection but also occur with other
enteric pathogens. No longer can diarrheal disease be looked upon only as an acute, short-lived, unpleasant nuisance.

**Salmonella in uncooked meat and poultry:** *Salmonella* continues to be a common contaminant of food products, particularly raw meat and poultry. While it is rather easily destroyed by heat in moist food products, it continually causes both large and small outbreaks of illness.

An outbreak of human salmonellosis from roast beef occurred in the New York area in 1969. The product was prepared from imported beef, and was nearly raw in the core. The firm's sanitation was poor. The product was recalled, and the firm was closed until many improvements were made. Other outbreaks occurred in 1971, 1974, two or three in 1975, and another in 1977. All of these were in the northeast and occurred in the late summer or early fall when the weather was hot. In 1977, FSIS passed emergency legislation requiring cooked beef to be heated to an internal temperature of 145°F.

A massive outbreak of human salmonellosis occurred during March of 1985 in the Chicago area from pasteurized 2% milk. More than 18,000 illnesses were reported to be associated with the production of a single dairy product, thus emphasizing the amplification of risk associated with high volume production. Since high volume production continues to be essential for profitability for industry and controlling price increases at the market, this may be one of the most important of the microbiological issues currently facing both the business community and scientists concerned with control. The interest in zero-defect control systems and microbial preservatives is growing.

Human populations throughout the world are continuing to grow and are concentrating heavily in metropolitan areas. Food processing establishments are similarly growing in size and production to more economically serve these population centers. The net result is that any accident or incident in food processing now may affect massive numbers of consumers. Because of better technology, such incidents will occur less frequently but when they do occur, they will be highly publicized because of the numbers involved.

**Clostridium botulinum:** Conventional (botulinum) food poisoning — botulism — results from the consumption of food in which *C. botulinum* has grown and produced its deadly neurotoxin. This poison interferes with transmission of nerve stimuli and causes paralysis. Beginning usually with blurred vision, then difficulty in talking and swallowing, and, finally, difficulty in breathing. For years, this disease has been a problem with certain home-preserved foods, but recent experience has revealed dangers from some unexpected commercial products (other than canned foods).

*C. Botulinum* is widely distributed in nature. It can produce spores which enable the organism to survive extremes of heat, drying, chemical exposure, and other unfavorable environmental conditions. to grow and
produce its toxin, the organism requires a relatively low-acid, low salt, and high-moisture food that is devoid of oxygen and stored without refrigeration. The safety of canned foods is assured by the application of sufficient heat to destroy the organism's spores. However, recent technological "advances" have permitted hazards to develop where none existed before.

Infant botulism was identified and named in 1976. Contrary to conventional foodborne botulism, this disease is a toxin infection of the lower bowel of very young children, usually between 1 week and 9 months of age. For some reason, the causal organism, *C. botulinum*, is able to colonize, grow, and produce toxin in the infant's colon. Thus far, more than 500 cases of infant botulism have been reported. States with the greatest number of recorded cases are California, Utah, and Pennsylvania, but no part of the country is known to be free of the problem.

Affected infants show typical signs of neurological distress — inability to cry normally, to suckle properly, to hold the head up, etc. (This condition is often called the "limp baby disease."). Surprisingly, there have been only one or two deaths, even though antimicrobial therapy is not recommended.

Almost all reported cases have involved *C. botulinum* types A and B. Organisms isolated from infants' stools appear identical to conventional strains of these types. It is generally assumed that the organisms come from the baby's environment. Breast-fed infants have developed the disease at least as frequently as those not breast-fed.

**Antibiotic resistance:** For several years, investigators have observed that persons undergoing antibiotic therapy are more likely to develop severe enteric illnesses. Apparently, while the healthy individual may be able to tolerate low levels of bacteria such as *Salmonella* in food without developing illness, persons on antibiotic therapy may develop serious illnesses under these same conditions. The percentage of consumers on antibiotic therapy is relatively high. Antibiotic-induced illness may result from bacteria that are naturally unaffected by the antibiotic in use or may result from bacteria that have acquired antibiotic resistance via medical or agricultural exposure. There is growing concern over the relative severity of antibiotic-induced illnesses caused by bacteria such as *Salmonella* bearing acquired antibiotic resistance. This issue is receiving a great deal of media attention in the U.S. today and has been a continual issue for years in the United Kingdom and Europe.

**Viruses:** One of the most serious viral diseases transmitted in food these ways is infectious hepatitis A, which has been known for a long time. A typical outbreak occurred in the summer of 1983 when an infected food handler at a restaurant in Oklahoma evidently contaminated a variety of foods, causing at least 203 cases of infectious hepatitis A among patrons of the restaurant.

Given the massive volume of food that is processed and consumed by the
population it is of no surprise that the disease incidence record is not perfect. Now we recognize new problems that we did not know about before but they undoubtedly existed. It is essential that efforts be made to continue to control microbial food problems. Efforts must be directed towards scientific progress as well as strong consumer education. At present, various government agencies, teaching and research institutions and private industries are aggressively involved in curbing the emerging pathogens before they become a problem.

REFERENCES

Parts of this presentation were quoted from “New Bacteria in the News” A Special Symposium as published in Food Technology, August 1986.
REPORT ON THE COMMITTEE ON PUBLIC HEALTH AND ENVIRONMENTAL QUALITY

Chairman: Dr. A. J. Roth, Richmond, VA
Vice Chairman: Dr. R. H. Singer, Winchester, KY

Dr. F. J. Alderink, MD; Dr. F. M. Applehans, TN; Dr. A. W. Bailey, OK; Dr. G. W. Beran, IA; Dr. R. P. Crawford, TX; Dr. S. L. Diesch, MN; Dr. C. R. Dorn, OH; Dr. D. W. Dreesen, GA; Dr. J. A. Farrar, GA; Dr. S. L. Hendricks, MN; Dr. W. E. Jennings, TX; Dr. J. C. Leighton, MD; Dr. R. E. Lowe, FL; Dr. F. V. McCasland, TX; Dr. E. L. Menning, DC; Dr. W. R. Miller, MD; Dr. R. L. Parker, SC; Dr. J. E. Pearson, IA; Dr. M. E. Potter, GA; Dr. J. C. Prucha, MD; Dr. W. T. Hubbert, MD; Dr. D. F. Schwindaman, MD; Dr. T. B. Siburt, VA; Dr. C. D. Stumpff, KS; Mr. L. D. Woodson, KS.

The committee on Public Health and Environmental Quality met at 1:30 p.m., Wednesday, October 22, 1986 as scheduled. A total of 15 members and 20 guests were in attendance.

Dr. Brij N. Bhargava, Microbiology Division, Science, Food Safety and Inspection Service, U.S. Department of Agriculture, Washington, D.C. presented a paper on Emerging Meat/Poultry Borne Pathogens. Dr. Bhargava’s paper presented foodborne disease outbreaks resulting from a variety of bacterial organisms some of which were not known to cause food poisoning or disease in the past. In view of the numerous foodborne disease outbreaks that have occurred involving the various emerging pathogens, this paper is attached to this report.

The committee discussed foodborne diseases and the increased incidence of foodborne disease outbreaks resulting from pathogens in pasteurized dairy products and other processed foods. In view of the prevalence and apparent increase of outbreaks involving such bacterial organisms as the various Salmonella species and the recent incidences involving Listeria monocytogenes, a subcommittee was appointed to investigate and study foodborne diseases. The immediate changes to the subcommittee were twofold:

1. To investigate and study the reasons for the disease outbreaks resulting from pasteurized dairy products.
2. To work with the Salmonella Committee for the purpose of formulating a comprehensive nationwide proposal to be presented as a joint effort to the U.S. Department of Agriculture for the reduction of Salmonellosis in both food and animals and man.

Dr. Stanley L. Diesch presented a paper on the hazard of pet European ferrets to human infants. Pet ferrets are becoming increasingly popular in the United States households. It is estimated that 50,000 to 75,000 ferrets are produced each year in the United States. It is estimated that a million
or more are kept as pets. There have been a number of reports in the United States in which household pet ferrets have attacked the infants inflicting a multitude of bites on the face around the mouth, ear, nose and eyes as well as over the arms and legs in a space of a few minutes without any provocation. In some instances the nose and mouth were totally mutilated.

Ferrets are also highly susceptible to rabies and at least seven rabid pet ferrets have been reported in the United States.

State and federal health and regulatory agencies should examine the growing public health and environmental concerns that exist with keeping of wild exotic animals including pet ferrets and consider regulations to control sales and restrict the ownership of hazardous wild animals including pet ferrets.

Dr. Tanya Roberts of the Economic Research Service of the U.S. Department of Agriculture presented a paper on the economic losses due to selected foodborne diseases. She reported that the costs caused by foodborne disease are just beginning to be quantified. A systematic methodology for measuring costs to individuals, firms and the public is still being developed. This paper estimates two cost components for individuals — medical costs and lost productivity — for five foodborne diseases. Salmonellosis and campylobacteriosis (which both cause intestinal disturbances with flu-like symptoms) each cause costs in the hundreds of millions of dollars annually, a low estimate because many cost components are not included. Trichinosis can cause a wide variety of ailments and has estimated costs of around three million annually. Beef tapeworm primarily causes discomfort and has estimated costs of one hundred thousand dollars annually. All five diseases can cause other chronic complications which are not included in the estimates.

Mr. Peter Swiderek, a member of the Southeastern Cooperative Wildlife Disease Study, College of Veterinary Medicine, University of Georgia, presented the various reasons for a need of a state regulation for the control of zoological animals. A model state regulation for control of zoological animals developed by the Study group was presented to the committee by Mr. Swinderek with a request that our committee endorse their efforts for the need for development of the proposed regulation and that the committee study the proposed regulation for possible correction and/or additions. A motion was made by Dr. Dale Schwindaman and seconded by Dr. David Dreesen that the committee endorse the need for a regulation for the control of zoological animals and to honor the request to study the proposed regulation. The motion was passed and four Committee members headed by Dr. Stanley Diesch and including Dr. David Dreesen, Dr. C. D. Stumpff and Dr. T. P. Siburt were appointed to study the proposed regulation.

An update of the Bovine Tuberculosis Program was presented by Dr. C. D. Stumpff. Dr. Stumpff reported that there were 22 herds infected with
bovine tuberculosis in the United States and Puerto Rico during fiscal year
1986. He again stressed that Mexico should be encouraged to institute an
effective bovine tuberculosis program. He also reported that there were
some employees of dairies whose herds were also infected with tubercu-
losis.

The meeting was adjourned at 5:00 p.m.

PET EUROPEAN FERRETS: A HAZARD TO HUMAN INFANTS

Stanley L. Diesch, DVM, MPH*

Pet ferrets are becoming increasingly popular in United States house-
holds. Estimates are that 50,000–75,000 ferrets are produced for pets each
year in the United States, mostly by commercial breeders. The demand for
purchase from pet stores appears to be greater than the supply. One
estimate indicates that a million or more are now kept as pets. The ferret is
known as the “trendy pet” or “yuppie pet.”

Ferrets, along with the skunk, otter, mink, and weasel, belong to the
family Mustelidae. Ferrets sold for pets in the U.S. are derived from
European stock and are reported domesticated for centuries. The ferret
commonly kept as a pet is Mustela putorius furo. The only wild indigenous
ferret in the United States is the black-footed ferret (Mustela nigripes). It is
among the rarest of the endangered mammals. Controversy surrounds the
public health status of ferrets as pets. A number of health risks can be
identified indicating that ferrets do not make appropriate pets, especially
where there are infants in the home.

Recently, Constantine¹ identified 22 pet ferret attacks on infants or
small children. The attacks ranged from a single bite to the death of a 6
month old child. Twelve attacks occurred while infants and young children
were in their crib or bed. Eight attacks were rated as serious. Ferrets also
often bite older children and adults, but the injuries associated with such
bites are seldom serious. Eighteen reports were in infants from 29 days to
two years of age.

Several reports of severe injuries of infants throughout the United
States resulted in a December 20, 1985 news release developed by the
Council on Public Health and Regulatory Veterinary Medicine for the
American Veterinary Medicine Association.² It recommended that ferrets
not be kept as pets. The following is the release:

“People who want ferrets as pets should know these increasingly popu-
lar animals can be dangerous to infants and small children, warns the
American Veterinary Medical Association (AVMA).

*Professor, Division of Veterinary Epidemiology, Food Hygiene, and Public Health, Col-
lege of Veterinary Medicine, University of Minnesota, St. Paul, MN 55108.

364
According to AVMA's Council on Public Health and Regulatory Veterinary Medicine, since 1981 five children in Colorado, Indiana, and Nevada have suffered extensive injuries during attacks by 'pet' ferrets.

The most recent documented cases occurred earlier this year.

A 29 day-old baby girl in Nevada was attacked while sleeping in her playpen by a five month-old ferret that was allowed to run loose in the home. The infant suffered extensive bite wounds on the face, especially around the eyes, nose, and mouth.

In Indiana, a six month-old child was attacked by a 'pet' ferret one week after the animal was found and captured in the yard. The ferret escaped from its cage and inflicted bites to the child's face, hands, and arm.

Luckily, in all five cases, the ferrets were found to be free of rabies. Ferrets can carry and transmit rabies, deadly virus of foxes, skunks, raccoons, bats, and other animals. There is no licensed, approved rabies vaccine for ferrets.

The ferret has become a popular 'pet' in recent years because its behavior and appearance is in many ways similar to the domestic cat. Recent estimates suggest a five-fold increase in ferret ownership in the last five years, with approximately 6,000 being sold each year as 'pets.'

Since 1973, the AVMA has opposed the keeping of wild or exotic animals as 'pets' and believes that commercial traffic in these animals for such purposes should be prohibited. However, some people in their concern for wildlife rabies claim that ferrets are not wild animals because many never live in the wild. California and various other cities and municipalities have already prohibited the keeping of ferrets as 'pets.'

The USAHA has addressed the subject of wild-exotic animals as pets because of rabies concern in 1980 and public health hazards in 1982. This 1985 news release of the AVMA generated controversy among veterinarians, ferret owners, and ferret breeders. The AVMA Council members examined further evidence on ferrets as pets on March 6–7, 1986, and reaffirmed its opinion that keeping ferrets as pets poses certain risks and hazards, especially to infants and other young children.

Humane societies also are discouraging ferrets as pets. They classify them as not truly domesticated. According to humane societies when ferrets are purchased as pets, owners find out that they bite and do general household damage due to chewing. When brought to an animal shelter, the general course of action is euthanasia. The Humane Society of the United States strongly opposes keeping ferrets as pets.

Four states — California, Georgia, New Hampshire, and South Carolina — and some cities including New York City, Cincinnati, Houston, Minneapolis, and St. Paul ban or severely restrict ferrets as pets. The Humane
Society of the United States is drafting legislation to submit to the 46 states that allow pet ferrets, asking that they be banned.

Pet ferrets are documented to be a public health hazard to infants. This statement is based on the increased reporting of unprovoked attacks on infants in their cribs, some of which have inflicted extensive, especially severe facial damage. Although scientific research information is not available as to why they attack infants, case reports indicate that their behavior is unpredictable. Some states, such as California and Colorado, are gathering information on the numbers and circumstances of bites.

Ferrets are highly susceptible to rabies. At least seven rabid pet ferrets have been reported in the United States. There is no licensed, approved rabies vaccine available for use in ferrets or other wild, exotic animals. Often when a ferret bites, they are euthanized and examined for rabies. Rabies vaccination of a ferret by a veterinarian is not accepted by health and regulatory officials as protection.

There is growing concern that ferrets, which have been extensively promoted as an ideal pet, may establish as feral population. This can result in excessive competition between native mustellids and feral ferrets. Competition could be a detriment to native skunks, weasels, mink, and certain avian species.

Studies in the State of Washington list the ferret *Mustela putorius* as a feral population on San Juan Island. They are increasing in numbers and are believed to be responsible for reducing native mink (*Mustela vision*) numbers in recent years. There had been an earlier introduction of a population of European rabbits to this island. In 1979, the rabbits were termed a social and economic pest. These are now reported to be decimated due to intense predation from ferrets on the island.

Documented evidence of wild populations of feral ferrets exists in New Zealand. These were initially introduced together with other predators to reduce the excessive population of rabbits. The ferrets played a role in reducing 20 endemic bird species including unique flightless birds such as the kakapo and the kiwi. Ferret owner associations claim that domestic ferrets do not and cannot survive in the wild.

State and federal health and regulatory agencies should examine the growing public health and environmental concerns that exist with the keeping of wild, exotic animals including pet ferrets. There is a definite need for regulations to control sales and restrict ownership, especially where there are infants in the home.

REFERENCES

1. Constantine, D. G. Personal communication, 3/6/86.


There are two quotations often heard during our daily activities, “That history repeats itself” and “A person’s problems are best understood by the questions he asks.” Both sayings are applicable to the United States rendering industry as they again find themselves being challenged to reduce the Salmonella recontamination in their animal proteins. In response, the conscientious renderer is asking, “What new methods or procedures are available to me today that were not available in the 1960s and 1970s that will aid me in reducing the Salmonella recontamination of my animal proteins.”

The National Renderers Association’s Salmonella Task Force spent better than one year reviewing and analyzing Salmonella research papers and discussing the Salmonella problem with distinguished scientists in the government, academic and private sectors. No new technology has been found that will assist the renderer with the questions previously mentioned.

In spite of these findings, it is obvious that renewed efforts must be made to reduce Salmonella recontamination levels of animal protein products. Thus, the NRA Salmonella Task Force worked to implement a voluntary industry-wide program in an effort to reduce Salmonella recontamination of animal protein products.

The Animal Protein Producers Industry (APPI) Salmonella Recontamination Reduction Program represents all segments of the rendering industry. These segments being: 1) NRA members; 2) packer renderers; 3) poultry processors; 4) protein blenders; and 5) other independent renderers.

The APPI program is an example of a Voluntary Compliance Program conducted by the Center of Veterinary Medicines (CVM) headed by Dr. William Bixler. The major points of the APPI Industry only self-help program are shown in the following slide.
SALMONELLA REDUCTION PROGRAM

— Industry members who meet minimal standards designated as APPI participant.
— Research — funded by entire Industry
  Antagonisis — look at PHMB
  Best disinfectants for our plants
  Gamma Irradiation
  Determine contamination points in plants
  Encourage continued feed pelleting research

Silliker Laboratories of Chicago Heights, Illinois was selected to test all samples during the program to eliminate a laboratory testing variables. The laboratory methodology utilized in sample analysis was that recommended by the Center of Veterinary Medicine (BAM Method) except that 75-gram instead of 25-gram samples were analyzed.

To determine at what point we were with Salmonella recontamination of animal protein products, it was necessary to determine benchmark data within each participating group. Each participating plant submitted ten (10) samples per month for two three month evaluation periods for laboratory analysis. The total number of plants in each category and the plants that signed up to participate in each group may be seen in the next slide. It is obvious that participation by some groups was excellent and very poor by other groups.

<table>
<thead>
<tr>
<th>PLANT CATEGORY</th>
<th>TOTAL NUMBER OF PLANTS</th>
<th>NUMBER OF PLANTS PHASE I</th>
<th>REGISTERED PHASE II</th>
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<tbody>
<tr>
<td>N.R.A. Members</td>
<td>153</td>
<td>82</td>
<td>77</td>
</tr>
<tr>
<td>Ind. Renderers</td>
<td>87</td>
<td>16</td>
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</tr>
<tr>
<td>Pro. Blenders</td>
<td>24</td>
<td>22</td>
<td>12</td>
</tr>
<tr>
<td>Poul. Processors</td>
<td>44</td>
<td>19</td>
<td>12</td>
</tr>
<tr>
<td>Packer/Rend.</td>
<td>149</td>
<td>27</td>
<td>20</td>
</tr>
<tr>
<td>Others</td>
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<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>457</td>
<td>167</td>
<td>131</td>
</tr>
</tbody>
</table>

The number of registered plants submitting samples during phase one may be seen in the next slide. It is evident that plants signed up to participate in the program did not always follow through with their commitment to submit samples for evaluation.
DAVIS

PHASE I
A.P.P.I. SALMONELLA SURVEY

<table>
<thead>
<tr>
<th>PLANT CATEGORY</th>
<th>NUMBER OF PLANTS REGISTERED</th>
<th>NUMBER OF PLANTS SUBMITTING SAMPLES</th>
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</thead>
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<tr>
<td></td>
<td></td>
<td>JULY</td>
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<tr>
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<tr>
<td>Pro. Blenders</td>
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<td>8</td>
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<tr>
<td>Poul. Processors</td>
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<td>10</td>
</tr>
<tr>
<td>Packer/Rend.</td>
<td>27</td>
<td>19</td>
</tr>
<tr>
<td>Others</td>
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<td>1</td>
</tr>
<tr>
<td></td>
<td>167</td>
<td>86</td>
</tr>
</tbody>
</table>

This seemed to be especially true during the phase two testing period.

PHASE II
A.P.P.I. SALMONELLA SURVEY

<table>
<thead>
<tr>
<th>PLANT CATEGORY</th>
<th>NUMBER OF PLANTS REGISTERED</th>
<th>NUMBER OF PLANTS SUBMITTING SAMPLES</th>
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<td></td>
<td>131</td>
<td>105</td>
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The number of samples submitted to Silliker Laboratories for analysis during phase one and phase two are shown on the next slide.

A.P.P.I. SALMONELLA SURVEY

<table>
<thead>
<tr>
<th>PLANT CATEGORY</th>
<th>NUMBER OF PLANTS REGISTERED</th>
<th>TOTAL SAMPLES SUBMITTED</th>
</tr>
</thead>
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<tr>
<td></td>
<td>PHASE I</td>
<td>PHASE II</td>
</tr>
<tr>
<td>N.R.A. Members</td>
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<td>17</td>
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<tr>
<td>Ind. Renderers</td>
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<tr>
<td>Others</td>
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<td>2</td>
</tr>
<tr>
<td></td>
<td>167</td>
<td>131</td>
</tr>
</tbody>
</table>

It is obvious that a sizable number of samples were submitted for analysis during both testing periods. As shown in the next two slides, the companies submitting samples do a good job of representing all geographic areas of the United States.
SALMONELLA REDUCTION PROGRAM

**PHASE I**
A.P.P.I. SALMONELLA SURVEY

<table>
<thead>
<tr>
<th>Geographic Area</th>
<th>Great Lakes States</th>
<th>S.E. North Central States</th>
<th>S.W. States</th>
<th>Rocky Mtn. States</th>
<th>Far West States</th>
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</tr>
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</table>

Total 17 26 40 43 15 8 18

**PHASE II**
A.P.P.I. SALMONELLA SURVEY

<table>
<thead>
<tr>
<th>Geographic Area</th>
<th>Great Lakes States</th>
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<th>Rocky Mtn. States</th>
<th>Far West States</th>
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<td>13</td>
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<td>Pro. Blenders</td>
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<tr>
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</table>

Total 19 23 21 34 11 5 16

The percent of Salmonella recontaminated samples found during the APPI benchmark testing program by participating member groups is shown in the next slide.

**A.P.P.I. SALMONELLA SURVEY**

<table>
<thead>
<tr>
<th>PLANT CATEGORY</th>
<th>Total Samples</th>
<th>% Samples Salmonella Positive</th>
<th>Total Samples</th>
<th>% Samples Salmonella Positive</th>
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<tbody>
<tr>
<td>N.R.A. Members</td>
<td>1,553</td>
<td>49.5</td>
<td>1,835</td>
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<td>Ind. Renderers</td>
<td>247</td>
<td>42.9</td>
<td>116</td>
<td>3.4</td>
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<tr>
<td>Poul. Processors</td>
<td>323</td>
<td>34.7</td>
<td>239</td>
<td>28.0</td>
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<tr>
<td>Packer/Rend.</td>
<td>605</td>
<td>63.6</td>
<td>449</td>
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<td>Others</td>
<td>29</td>
<td>65.5</td>
<td>30</td>
<td>60.0</td>
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</tbody>
</table>

Total 3,160 55.1 2,849 40.9

These values are similar to those found at the start of the U.S.D.A. Salmonella Evaluation Program during the early 1960s. It should be made evident that the positive findings in this testing program were found with
a laboratory method far more sensitive (3 to 5 times) than the methodology utilized in the 60s. Thus, it seems obvious that the recontamination of samples is not as severe today as in past years.

It should be noted that the positive number of samples in each category declined during the phase two testing period.

The next slide indicates that the number of Salmonella organisms per 100 grams of sample were extremely low.

**A.P.P.I. SALMONELLA SURVEY**

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>PHASE I</th>
<th>PHASE II</th>
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<tbody>
<tr>
<td>Feather Meal</td>
<td>Less than 0.15</td>
<td>2.48</td>
</tr>
<tr>
<td>Meat and Bone Meal</td>
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<td>4.43</td>
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<tr>
<td>Poultry Meal</td>
<td>—</td>
<td>2.65</td>
</tr>
<tr>
<td>Dry Rendered Tankage</td>
<td>5.41</td>
<td>—</td>
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</table>

These values would indicate that the Salmonella recontamination found in these animal protein materials are probably caused by airborne organisms. It should also be mentioned that these values are considerably below the one organism per gram level felt to be of significance in finished feed products by many scientists. These scientists believe that it requires at least one organism per gram of finished feed to cause sub-clinical disease problems with growing animals.

The second phase of this reduction program will be education and implementation. This program will consist of programs and materials designed to assist all employees of the rendering operation in avoiding or reducing the incidence of Salmonella recontamination. This phase of the program will include a video presentation, posters, brochures, color coding equipment and areas, APPI stickers and APPI Certificates of participation. Other information materials that are pertinent may also be included. It will also include, at a nominal cost, assistance from special consultants who will work on specific problems within a plant.

A third phase of the APPI program will consist of research. This program will evaluate the utilization of various products and means to reduce Salmonella recontamination of animal proteins.

The fourth phase of the APPI program will be continued evaluation of animal protein products for Salmonella recontamination. This program will include testing of product at different time periods in the years ahead.

The Animal Protein Producing Industry Program has determined benchmark data for Salmonella recontamination in animal proteins that is quite similar to data found in the early ’60s. However, the organisms per gram of these positive samples were found to be quite low. Thus, it is quite evident that animal protein products are not the major cause of Salmonellosis problems in livestock programs. However, the APPI program will
SALMONELLA REDUCTION PROGRAM

continue to monitor animal protein products while working on educational, training and research programs to assist in further reduction of Salmonella recontamination of animal proteins.

The Animal Protein Producing Industry Committee welcomes suggestions and assistance from this group of distinguished scientists and we are confident that our combined efforts will result in practical and cost effective procedures to control Salmonella recontamination in rendering and blending facilities.
SALMONELLA NEWPORT IN CATTLE:
AN ANIMAL AND HUMAN HEALTH PROBLEM

Richard E. Pacer, D.V.M.*
Mark C. Thurmond, D.V.M., Ph.D.**
C. Patrick Ryan, D.V.M., M.P.H.***
John S. Spika, M.D.****
Morris E. Potter, D.V.M.****

INTRODUCTION

Despite the efforts of local, State, and Federal health agencies, outbreaks of food- and milk-borne disease continue to occur. Between 1973 and 1982, the number of outbreaks reported to the Centers for Disease Control (CDC) has doubled to 656 outbreaks involving nearly 20,000 cases of foodborne disease in 1982. Of the reported meatborne outbreaks during the 10-year period, 31% were attributed to beef, 44% to pork, and 25% to poultry.

We recently investigated a human food-borne outbreak resulting from contamination of a red meat product by *Salmonella newport*. The extent to which this outbreak was successfully investigated can be attributed largely to the cooperation and insight of the industry, State, and Federal agencies and individuals involved. Unfortunately, the programs and steps implemented to keep our livestock and poultry healthy are sometimes considered incompatible with those focusing on public health, which tends to limit information-sharing among interested parties. To illustrate the benefits of cooperative efforts in the investigation of zoonoses, I would like to summarize our recent investigation of *S. newport* in cattle and humans in California.

INVESTIGATIVE PROCEDURES AND RESULTS

*S. newport* Identified in Humans

In May 1985, the Los Angeles (LA) County Health Department noticed an increase in the number of isolates of *S. newport* serotyped, compared with previous years. Many of the isolates of *S. newport* had an unusual antibiogram, which included resistance to chloramphenicol and a single identical plasmid. Resistance to chloramphenicol has been recognized at low frequencies among selected *Salmonella* serotypes; however, the magnitude of the increase both in total number of isolates and percentage with this antibiogram suggested the introduction of a new strain. We used the antimicrobial resistance pattern and plasmid profile as “fingerprints” of

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SALMONELLA NEWPORT IN CATTLE

this multiply-resistant S. newport to help us identify hamburger both epidemiologically and microbiologically as the vehicle of transmission and then to trace this strain back to the herds of origin.¹

The number of human Salmonella isolates for all serotypes identified through the surveillance system in California for 1985 was similar to that for 1984; however, before 1985, S. typhimurium was the most frequently identified serotype in California. In 1985, the number of isolates of S. typhimurium in humans dropped, and S. newport became the most common serotype.¹ A case-control study, performed as part of the investigation, demonstrated an association between illness and consumption of ground beef (OR = 7.9; p = 0.052). A single producer of hamburger was significantly associated with cases, but only 20% of patients ate that hamburger.

S. newport Identified in Beef Products and on Farms

During the investigation, we isolated the epidemic strain from four illness-associated hamburger specimens. Using two of these specimens identified through a restaurant-associated outbreak plus four other meat specimens found to harbor the epidemic strain by USDA Food Safety Inspection Service (FSIS) through its surveillance of precooked roast beef products, we identified one meat deboning plant as a common source of raw beef. The six production dates for these identified meat products were then used retrospectively to identify one abattoir that was the most likely source of carcass meat for all six days. The two other illness-associated hamburger specimens from which the epidemic strain was isolated were also traced to this abattoir. This traceback process was repeated at the abattoir and identified seven dairies in one dairy farming area that sent a relatively large number of their least productive cows to slaughter on days linked to disease-associated carcasses. The epidemic strain was recovered from calves, adult cows, or waste lagoons at three of these seven suspect dairies. This and one other dairy area were the sources of five isolates of the epidemic strain of S. newport found through a review of all veterinary isolates from California diagnostic laboratories.

On-Farm Dairy Surveys Completed in California

As part of the investigation, we attempted to trace the implicated hamburger through the food chain to the herds-of-origin, and to determine risk factors for the presence of the epidemic strain and/or other resistant Salmonella. Isolates of S. newport from domestic animals, submitted to the USDA’s National Veterinary Services Laboratories (NVSL) in Ames, Iowa, were screened for the outbreak antibiogram and plasmid profile. This identified infected beef and dairy herds in a number of western States, plus a few dog kennels wherein dogs were fed raw meat. Because of the numerous human cases of salmonellosis in California, we first placed emphasis on investigating animals in that State. We identified two dairy
areas in California suspected of harboring cattle infected with the epidemiic strain of *S. newport*, using data from NVSL, the California Department of Food and Agriculture's diagnostic laboratories, and FSIS. We undertook an extensive epidemiologic and microbiologic survey of these two areas to determine the prevalence of this organism and risk factors for its presence. In addition, we determined the prevalence and antimicrobial resistance of other salmonella infecting cattle in these two dairy areas.

We designed a questionnaire to identify possible risk factors associated with the presence of this organism on a dairy. Information collected included the current number of dairy cattle by category of use (e.g., calves, dry cows, lactating cows), rate of calf mortality, unusual illness in adult cattle and replacement heifers, management practices regarding antibiotic usage, *Salmonella* bacterin usage, feed sources, and feeding practices. In addition to the questionnaire, fecal samples were collected from adult cattle, calves, and dairy waste lagoons. Samples were transported to nearby veterinary diagnostic laboratories on the day of collection for primary bacterial culture. Serotyping and antimicrobial sensitivity testing were later performed at NVSL and CDC by standards methods.

The first dairy survey, survey A, was conducted in a highly concentrated dairy area of southern California in December, 1985. Seventy (78%) of 90 randomly selected dairies volunteered to participate in survey A. A second on-farm dairy survey was conducted in late January—early February, 1986, in a county in central California, survey B. In this survey, 75 (83%) of 90 randomly selected dairies participated.

In survey A, *Salmonella* was isolated from at least one sampling site on 29 (41%) of 70 dairies. Eleven (38%) of these 29 dairies were positive for *S. meunster*, which was the most frequently isolated serotypes. *S. dublin* and *S. meleagridis*, the second most frequently isolated serotypes, were recovered from five (17%) of the 29 positive dairies. Fourteen percent of salmonellae isolated were resistant to one or more of the 12 antimicrobial agents tested (Table 1). Multiply-resistant strains of *Salmonella* were recovered from 24% of the *Salmonella* positive dairies. Resistance to seven antimicrobials was expressed by one of five *S. dublin* isolates and one untyped *Salmonella* group C2 isolate. Two other *S. dublin* isolates were resistant to five antimicrobials, and three of four *S. typhimurium* isolates were resistant to six antimicrobials. The remaining isolates identified in survey A were sensitive to the 12 antibiotics tested.

In survey B, 12 (16%) of 75 dairies yielded *Salmonella* from at least one of the four sampling sites. *S. newport* was isolated from half of the dairies that had *Salmonella* present. Nearly 75% of the isolates of salmonellae were resistant to ampicillin-carbenicillin-chloramphenicol-kanamycin-streptomycin-sulfasoxazole-tetracycline. These multiply-resistant isolates included two *S. dublin* and 11 *S. newport* isolates. The antimicrobial resistance pattern and plasmid profile of the *S. newport* isolates were
identical to the epidemic strain of S. newport causing illness in humans in California.

The most frequently reported antibiotics used to treat dairy animals on the 145 dairies in southern and central California included: penicillin (95%), tetracyclines (86%), and sulfa drugs (83%). Antibiotics reported to have been used least during the 18 months preceding these surveys included: chloramphenicol (12%), trimethoprim (3%), and lincomycin (1%). Three (38%) of eight dairies with chloramphenicol-resistant Salmonella in survey B reported use of chloramphenicol during the previous 18 months compared with four (6%) of 67 dairies having no Salmonella or chloramphenicol-sensitive serotypes isolated (OR = 9.5; p = 0.023, Fisher’s exact test, 2-tailed). The strong association suggests that chloramphenicol administration by dairies surveyed in this investigation may have contributed to the emergence of this resistant bacterium. We are continuing to analyze data gathered on the questionnaires to attempt to determine other possible associations between management practices and the presence of this organism on the farm.

S. newport Identified in Cattle in Other States

In March, 1986, we focused our attention on isolates of the epidemic strain of S. newport identified in other states, including Colorado, Kansas, Nebraska, and New Mexico. These isolates were obtained from NVSL for the years 1984 and 1985. Preliminary information was compiled by telephone interviews with clinicians and laboratorians involved with these S. newport cases at university and State diagnostic facilities. A questionnaire similar to the one used in the California dairy surveys was administered by telephone to the owners of these positive premises, including dairymen and ranches raising dairy and/or beef animals on farm or feedlot operations.

Of the eight individuals interviewed, five raised beef cattle, either primarily or exclusively, and three raised dairy cattle. The types of operations ranged from small backyard producers of feeder calves to large feedlots raising several thousand cattle. The dairy surveys in California had revealed that some dairymen in southern and central California raised their replacement heifers in Idaho. The majority of these heifers moved back to California; however, during the past three years, some of them were transported to dairies in northern Colorado (Figure 1). In addition, dairy bull calves from infected premises in southern California were transported to sales yards near Amarillo, Texas, and were then dispersed to farms and feedlots in surrounding states. The movement of these cattle preceded the onset of illness in cattle in the central mountain States, leading us to believe that the cases of S. newport outside of California might be associated with the movement of live dairy cattle through market channels, rather than through common exposure to feed, semen, or other substances, or to the emergence of an identical strain of S.
newport in widely separated geographical areas. The possibility of mixing of dairy and beef and/or their manure at auction yards is quite likely.

DISCUSSION

Others have reported that infected animals may not exhibit clinical signs of salmonellosis until stressed or treated with antibiotics. Owners outside of California included in the last survey reported onset of severe diarrhea a couple of days following the administration of antibiotics for another illness in 57% of S. newport infected premises. Therapeutic or subtherapeutic use of antibiotics, such as the feeding of medicated milk replacers or feed rations, may predispose carrier animals of multiply-resistant bacteria to disease. This phenomenon has already been shown to occur in humans, and it is not unreasonable to believe that a similar situation is occurring in animals.

It is impossible to determine the origin of this new multiply-resistant strain of Salmonella. The California Microbial Diseases Laboratory and NVSL had discarded their Salmonella isolates from before 1984. We were able to determine that this strain caused disease in humans in Santa Cruz, California in April, 1984. Because this involved only a small number of individuals and the outbreak was self-limiting, the local health department performed a limited investigation. In animals, we were able to identify disease caused by the epidemic strain of S. newport in a dairy in central California in October, 1984. Information gathered from owners of the earliest known animal cases led us to believe that this organism could have been causing illness in cattle as early as the summer of 1984, but its earlier role in the animals illnesses may have gone unappreciated.

This multiply-resistant strain of S. newport continues to cause illness and, in some cases, death in human and animal populations. Since the investigation of the above cases, we have been notified of infected animals in at least two other States, namely, Texas and Washington. At least three animal industries are currently faced with problems as a result of this bacteria, including dairy cattle, beef cattle, and racing greyhounds. Dairymen and ranchers affected by this organism are aware of the direct economic impact of its presence in their herds. The direct and indirect costs of contaminated beef products entering the food chain are at this time unknown. However, one needs only to look at news headlines to realize that contaminated food products cost money.

Further studies through the cooperative efforts of industry, State, and Federal officials on the persistence and economic impact of this organism on farms and feedlots in the western and central U.S. and their associated meat processing industries can and should be pursued. Because of the biological markers or "fingerprints" which this epidemic strain of S. newport possesses, it is readily traceable and may shed light on the entry and movement of Salmonella through animal populations and the food chain, and ultimately identify points for its elimination or control. Let us
not turn our backs on the progress that has been made to date regarding the epidemiology of his disease.

REFERENCES

1. Spika, J. S., Waterman, S. H., Soo Hoo, G., et.al. Chloramphenicolresistant Salmonella newport traced through hamburger to dairy farms: A major persisting source of human salmonellosis in California. (Submitted for publication.)


Table 1. Panel of Antimicrobial Agents Tested Against Salmonellae Identified in Surveys A and B.

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Antimicrobial Agents Tested Against Salmonellae</th>
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<tr>
<td>Ampicillin</td>
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<td>Carbenicillin</td>
<td>Streptomycin</td>
</tr>
<tr>
<td>Cephalothin</td>
<td>Sulfasoxazole</td>
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<td>Trimethoprim</td>
</tr>
<tr>
<td>Kanamycin</td>
<td>Trimethoprim/Sulfamethoxizole</td>
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</tbody>
</table>

379
Figure 1. Proposed Spread of *Salmonella* *newport* in Cattle in the United States, 1984-1986

- Multiply antibiotic resistant *S. newport* identified in cattle
- 1° Movement of exposed cattle
- 2° Movement of exposed cattle
SUMMARY

Serotyping of salmonella cultures from animal disease cases and epidemiologically related sources is reported for October 1, 1984, through September 30, 1985 (FY 1985). A total of 5605 cultures were serotyped. The most frequently identified serotypes were *Salmonella typhimurium*, *S. cholerasuis* var. kunzendorf, *S. heidelberg*, *S. typhimurium* var. copenhagen, and *Salmonella 18:Z4,Z32* (Arizona). The most frequent sources of cultures were turkeys followed by cattle, swine, and chickens.

INTRODUCTION

Data for this report were accumulated at the National Veterinary Services Laboratories, Veterinary Services, Animal and Plant Health Inspection Service (APHIS), USDA, Ames, Iowa. The data, except for serotyping results, were provided by the many laboratories requesting serotyping services. Most of these laboratories appreciate the importance of accurate data and made a concerted effort to provide quality input. Also, the reports were screened for obvious errors. However, it was not possible to verify each entry, and the quality of the total report is a reflection of the cooperative spirit of these laboratories.

The purpose of this report is to make the data available to epidemiologists and others who have a need for it. The data are presented in tables similar to previous reports in order that comparisons can be easily made. For this reason, although isolates formerly identified as "Arizona" are now reported on the basis of their corresponding salmonella antigens, they are separately reported in Tables 3 and 4.

DISCUSSION

Cultures were received for serotyping from 46 states, the District of Columbia, and Puerto Rico. A total of 5605 cultures were serotyped, which was an increase over the number serotyped in FY 84 (5391) and close to the 5649 cultures serotyped in FY 83.

A total of 203 serotypes were identified (Tables 1–4). Fifty-six percent of the total cultures serotyped were identified as one of the most common serotypes listed in Table 10. Forty-six of the 203 serotypes were only identified once.
Six serotypes were identified which had not been previously described from animal sources in the United States. *S. bonaire* was isolated from a red-headed basilisk in Oklahoma (Oklahoma City Zoo), *S. chicago* from an iguana in New York, *S. ealing* from a goose in Maryland, *S. epicrates* from a sample of turkey meat in California, *S. rissen* from a sheep in Texas, and *S. tennyson* from a sheep in Texas.

*S. indiana* was identified 129 times, which was a noticeable increase over the previous 5 years. The highest number of isolates of this serotype identified in the previous 5 years was 47 in FY 1984. Isolates were received from 12 states, but the majority (56%) were from Colorado (Table 11). One hundred twenty-one (94%) of the isolates were from turkeys; and, of the remaining isolates, two were from chickens, one from a pigeon, one from swine, one from feed, one was environmental, and two were from miscellaneous sources (Table 2).

*S. kottbus* identifications increased from 0 to 72. A majority (96%) of these were from turkeys in Utah. This serotype was previously identified twice in FY 1982 and seven times in FY 1980.

*S. amsterdam* increased from 11 in 1984 to 70. There were no isolations of this serotype reported in 1981 and 1983, and fewer than five were identified in 1980 and 1982. Sixty-five isolates were from rodents in Illinois.

The number of isolations of *S. cerro* increased to 110 from 54 in 1984. An increase in this serotype was noted in the FY 83 report. At that time, 36% of these isolates were of turkey origin and 16% were bovine isolates. This is in contrast to the isolates in Table 2; 6% were turkey isolates, 41% were bovine isolates, and 25% were from feed. Isolates were submitted from 15 states; one-third of the isolates were from animals in Texas.

*S. brandenburg* isolates increased from five in 1984 to 21. In 1984, all were from Minnesota from turkeys or feed. Turkeys were the most common source of isolates (57%) with isolations from ducks, cattle, swine, feed, environment, and miscellaneous sources also being identified (Table 2). Isolates were received from four states with the majority from Minnesota (76%).

Forty-one isolates of *S. hadar* were identified, which was the largest number of isolates since the 63 reported in 1981. Only 17 isolates of *S. hadar* were identified in 1984. This serotype was not reported from North Carolina and California in FY 1981. Isolates of *S. hadar* were identified from North Carolina every year since 1981; and although isolates were received from 12 states this year, 21 were from North Carolina. Forty-four percent of the isolates were of turkey origin and 22% were from chickens.

Isolations of *S. mbanda* continued to increase, although the increase was not as great as that observed in FY 1984. There were 83 isolates from 15 states. Isolates from chickens (26) and cattle (23) accounted for 59% of the isolates received.
SALMONELLA SEROTYPES FROM ANIMALS

REFERENCES


### Table 1: Distribution of Salmonella Serotypes by State - FY 1981

<p>| Serotype | AL | AZ | AR | CA | CO | DC | DC | FL | GA | ID | IL | IN | IA | KS | KY | LA | ME | MD | MA | MI | MN | MO | MS | MT | NE | NH | NJ | NY | NC | ND | OH | OK | OR | PA | RI | SC | SD | TN | TX | UT | VA | WA | WI | WY |
|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| FERRIS   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| MURPHY   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| BLACKBURN|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |</p>
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<td><strong>CERRO</strong></td>
<td>45</td>
<td>163</td>
<td>100</td>
<td>9.2</td>
<td>100</td>
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<tr>
<td><strong>NEWPORT</strong></td>
<td>39</td>
<td>159</td>
<td>100</td>
<td>7.4</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td><strong>MELEAGRIDIS</strong></td>
<td>36</td>
<td>206</td>
<td>100</td>
<td>7.8</td>
<td>100</td>
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</tr>
<tr>
<td><strong>MUENCHEN</strong></td>
<td>25</td>
<td>134</td>
<td>100</td>
<td>9.6</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td><strong>ALL OTHERS</strong></td>
<td>203</td>
<td>156</td>
<td>100</td>
<td>9.4</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Percent Morbidity: HIGHEST AVERAGE
- **TYPHIMURIUM**: 100
- **DUBLIN**: 100
- **TYPHIMURIUM (COPENHAGEN)**: 100
- **ANATUM**: 100
- **MUENSTER**: 100
- **MONTEVIDEO**: 100
- **CERRO**: 100
- **NEWPORT**: 100
- **MELEAGRIDIS**: 100
- **MUENCHEN**: 100
- **ALL OTHERS**: 100

Percent Mortality: HIGHEST AVERAGE
- **TYPHIMURIUM**: 2.2
- **DUBLIN**: 5.5
- **TYPHIMURIUM (COPENHAGEN)**: 2.7
- **ANATUM**: 1.5
- **MUENSTER**: 1.2
- **MONTEVIDEO**: 1.5
- **CERRO**: 1.2
- **NEWPORT**: 1.8
- **MELEAGRIDIS**: 6.6
- **MUENCHEN**: 3.2
- **ALL OTHERS**: 2.1
<table>
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<tr>
<th>SEROTYPE</th>
<th>TIMES IDENTIFIED</th>
<th>AVE. HERD SIZE</th>
<th>PERCENT HIGHEST</th>
<th>MORBIDITY AVERAGE</th>
<th>PERCENT MORTALITY HIGHEST</th>
<th>MORTALITY AVERAGE</th>
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<tr>
<td>CHOLERASUIS (KUNZENDORF)</td>
<td>554</td>
<td>324</td>
<td>100</td>
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<tr>
<td>TYPHIMURIUM</td>
<td>40</td>
<td>587</td>
<td>100</td>
<td>11.9</td>
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<td>DERBY</td>
<td>29</td>
<td>408</td>
<td>100</td>
<td>39.5</td>
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<td>2.5</td>
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<td>TYPHIMURIUM (COPENHAGEN)</td>
<td>17</td>
<td>805</td>
<td>75</td>
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<td>ANATUM</td>
<td>16</td>
<td>160</td>
<td>100</td>
<td>35.0</td>
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<td>4.3</td>
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<tr>
<td>ENTERITIDIS</td>
<td>14</td>
<td>4411</td>
<td>100</td>
<td>.9</td>
<td>100</td>
<td>.2</td>
</tr>
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<td>INFANTIS</td>
<td>13</td>
<td>632</td>
<td>75</td>
<td>54.0</td>
<td>43</td>
<td>7.9</td>
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<tr>
<td>AGONA</td>
<td>12</td>
<td>299</td>
<td>75</td>
<td>13.8</td>
<td>75</td>
<td>7.5</td>
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<td>MUYENCHEN</td>
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<td>64</td>
<td>67</td>
<td>6.0</td>
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<td>HEIDELBERG</td>
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<td>536</td>
<td>12</td>
<td>2.2</td>
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<td>.7</td>
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<tr>
<td>ALL OTHERS</td>
<td>50</td>
<td>231</td>
<td>100</td>
<td>6.8</td>
<td>100</td>
<td>1.9</td>
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</table>
TABLE 9.  HORSE--MOST FREQUENTLY IDENTIFIED SEROTYPES IN FY85

<table>
<thead>
<tr>
<th>SEROTYPE</th>
<th>TIMES IDENTIFIED</th>
<th>AVE. HERD SIZE</th>
<th>PERCENT HIGHEST</th>
<th>PERCENT MORBIDITY AVERAGE</th>
<th>PERCENT HIGHEST</th>
<th>MORTALITY AVERAGE</th>
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<tr>
<td>SAINT-PAUL</td>
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<td>TYPHIMURIUM</td>
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<td>KREFELD</td>
<td>33</td>
<td>4</td>
<td>100</td>
<td>66.7</td>
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<td>4.7</td>
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<tr>
<td>AGONA</td>
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<td>37</td>
<td>100</td>
<td>24.4</td>
<td>100</td>
<td>3.8</td>
</tr>
<tr>
<td>NEWPORT</td>
<td>22</td>
<td>9</td>
<td>100</td>
<td>20.1</td>
<td>100</td>
<td>6.7</td>
</tr>
<tr>
<td>MELEAGRIDIS</td>
<td>19</td>
<td>79</td>
<td>100</td>
<td>2.3</td>
<td>100</td>
<td>2.2</td>
</tr>
<tr>
<td>MUECHEN</td>
<td>17</td>
<td>16</td>
<td>100</td>
<td>7.3</td>
<td>100</td>
<td>4.4</td>
</tr>
<tr>
<td>TYPHIMURIUM (COPENHAGEN)</td>
<td>15</td>
<td>18</td>
<td>100</td>
<td>7.6</td>
<td>100</td>
<td>3.4</td>
</tr>
<tr>
<td>ANATUM</td>
<td>13</td>
<td>25</td>
<td>100</td>
<td>16.3</td>
<td>100</td>
<td>2.8</td>
</tr>
<tr>
<td>ORANIENBURG</td>
<td>6</td>
<td>337</td>
<td>100</td>
<td>1.2</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>ALL OTHERS</td>
<td>63</td>
<td>28</td>
<td>100</td>
<td>7.9</td>
<td>100</td>
<td>2.1</td>
</tr>
</tbody>
</table>
Table 10. Salmonella Serotypes Identified Most Frequently During FY 1985 with Comparison Data for 5 Years (All Sources)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPHIMURIUM</td>
<td>682*</td>
<td>809 (1)</td>
<td>958 (1)</td>
<td>981 (1)</td>
<td>844 (1)</td>
<td>790 (1)</td>
</tr>
<tr>
<td>CHOLERASUIS</td>
<td>559 (2)</td>
<td>562 (2)</td>
<td>592 (2)</td>
<td>621 (2)</td>
<td>611 (2)</td>
<td>706 (2)</td>
</tr>
<tr>
<td>(KUNZENDORF)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HEIDELBERG</td>
<td>368 (3)</td>
<td>399 (3)</td>
<td>380 (3)</td>
<td>234 (5)</td>
<td>214 (5)</td>
<td>321 (4)</td>
</tr>
<tr>
<td>TYPHIMURIUM</td>
<td>292 (4)</td>
<td>309 (4)</td>
<td>377 (4)</td>
<td>433 (3)</td>
<td>579 (3)</td>
<td>380 (3)</td>
</tr>
<tr>
<td>(COPENHAGEN)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18:Z4,Z32 (ARIZONA)***</td>
<td>240 (5)</td>
<td>273 (5)</td>
<td>311</td>
<td>224</td>
<td>135</td>
<td>82</td>
</tr>
<tr>
<td>ANATUM</td>
<td>195 (6)</td>
<td>170 (9)</td>
<td>175 (6)</td>
<td>236 (4)</td>
<td>191 (6)</td>
<td>179 (7)</td>
</tr>
<tr>
<td>MONTEVIDEO</td>
<td>176 (7)</td>
<td>183 (8)</td>
<td>122 (10)</td>
<td>127 (11)</td>
<td>117 (10)</td>
<td>61 (13)</td>
</tr>
<tr>
<td>AGONA</td>
<td>173 (8)</td>
<td>217 (6)</td>
<td>198 (5)</td>
<td>157 (9)</td>
<td>158 (7)</td>
<td>203 (5)</td>
</tr>
<tr>
<td>SANDIEGO</td>
<td>173 (8)</td>
<td>60 (19)</td>
<td>164 (7)</td>
<td>141 (10)</td>
<td>52 (16)</td>
<td>48 (14)</td>
</tr>
<tr>
<td>SAINTPAUL</td>
<td>154 (9)</td>
<td>83 (14)</td>
<td>95 (13)</td>
<td>223 (6)</td>
<td>117 (10)</td>
<td>119 (9)</td>
</tr>
<tr>
<td>DUBLIN</td>
<td>140 (10)</td>
<td>208 (7)</td>
<td>136 (9)</td>
<td>198 (7)</td>
<td>246 (4)</td>
<td>197 (6)</td>
</tr>
</tbody>
</table>

*Number of times serotype was identified
**Rank beginning with the most common
***First included in this table in FY 1984
REPORT OF THE COMMITTEE ON SALMONELLA

Chairman: Dr. B. S. Pomeroy, St. Paul, MN  
Vice Chairman: Dr. G. H. Snoeyenbos, Amherst, MA

Dr. C. W. Beard, GA; Dr. D. F. Bisplinghoff, FL; Dr. B. O. Blackburn, IA; Dr. T. E. Carpenter, CA; Dr. J. R. Cole, GA; Dr. M. L. Crandall, MD; Dr. L. E. Davis, IL; Dr. W. H. Dubbert, DC; Dr. F. R. Fields, AL; Dr. R. D. Glock, AZ; Dr. E. E. Grass, MD; Dr. R. W. Griffith, IA; Dr. D. A. Halvorson, MN; Dr. D. W. Hird, CA; Dr. D. C. Johnson, GA; Dr. W. L. Kadel, KY; Dr. L. M. Kennedy, VA; Dr. D. D. King, MD; Dr. G. E. Kolb, WI; Dr. T. T. Kramer, IA; Dr. C. L'Ecuyer, Canada; Dr. E. T. Mallinson, MD; Dr. C. S. McCain, OK; Dr. P. L. McDonough, NY; Dr. E. L. Menning, DC; Dr. G. W. Meyerholz, DC; Dr. C. D. Murphy, IA; Dr. K. V. Nagaraja, MN; Dr. H. J. Olander, CA; Dr. I. L. Peterson, MD; Dr. R. E. Pacer, GA; Dr. M. E. Potter, GA; Dr. R. A. Robinson, MN; Dr. M. Rosenstein, AR; Dr. L. D. Schwartz, MI; Ms. K. Sutch, IA; Mr. W. T. Tramel, MS; Dr. K. VanSteenbergh, MO; Dr. S. A. Vezey, GA; Dr. M. W. Vorhies, SD; Dr. R. D. Welsh, TX; Mr. C. R. Weston, NH.

Ex-Officio: W. B. Bixler, MD.

The committee met at 1:30 p.m., Monday, October 20, 1986. Twenty-seven members and 16 guests attended.

Seven general reports were presented to the committee.

1. Dr. B. O. Blackburn reported for Kathleen Ferris, C. D. Murphy on Salmonella Serotypes from Animals and Related Sources Reported During Fiscal Year 1985 (Salmonella Typing Laboratory, NVSL). Serotyping of Salmonella cultures from animal disease cases and epidemiologically related sources were reported for October, 1984 through September 30, 1985. A total of 5,605 cultures were serotyped. The five most frequent serotypes were unchanged from the previous year. Some sharp increases of some serotypes were noted as a result of higher incidence in local geographic areas. Phage work will be discontinued as less informative than plasmid analysis which will be provided on request. A complete report will be published in the proceedings of this meeting.

2. Dr. Patrick L. McDonough of Tufks University reported on Epidemiological Studies of Clonal Groups of Salmonella typhimurium. The epidemiology of 278 strains of S. typhimurium isolated during 1973–81 from animals in NY state was studied by several methods. These methods include phage typing, biotyping, plasmid analysis, and analysis of antibiogram pattern, which provided markers useful in fingerprinting each salmonella strain. The markers were used to define the reservoir of S. typhimurium infection in animals. Phage type (PT) and biotype (BT) were the most useful markers to differentiate the bacterial strains. The PT/BT groups were distributed by
REPORT OF THE COMMITTEE

year of isolation, county of origin, and host animal species. Five PT/BT groups occurred most frequently, U275/26, 49/26, 10/3, 2/3, and 191/17. Strains with the same PT/BT were called a clonal group, especially when the clonal status was supported by other markers such as plasmid profile. Antibiogram pattern was not a useful epidemiological marker for strains, because strains with the same antibiogram often had different plasmid profiles.

3. Dr. Claude Lavigne, Health of Animals Directorate, Food Production and Inspection Branch, Agriculture Canada reported on the developments of the Canadian Salmonella Control Programs within the last year.

In addition to normal monitoring of the bacteriological profiles of meat products as part of the Meat Hygiene program, beef, pork and chicken broiler carcasses were examined for the presence of Salmonella. In a national survey of 329 beef, 318 pork and 225 poultry carcasses in the year ending March 31, 1986, the percentages of carcass Salmonella contamination were 2.4% (muscle sample) and 2.7% (lymph node sample) for beef, 10.4% (muscle sample) and 11.9% (lymph node sample) for pork, and 72% for broiler chickens. A training module on introductory food microbiology is being prepared in script format for use by agricultural field inspectors.

In the Dairy segment of the program, Branch personnel are participating with industry in the development of standardized national GMP guidelines for pasteurization. The development of a training module for field staff on sampling of dairy products for microbiological analysis is also being undertaken. The monitoring of the product and of the environment in powdered milk plants has been altered to increase the role of industry.

A management review of the Branch Feed Program was completed with industry participation in April of 1986. Recommendations from this review will enable the development of required legislation to permit prescribing manufacturing standards for the Canadian feed industry, resulting in greater control of Salmonella in livestock feed. The monitoring of livestock feeds and feed ingredients on a non-statistical basis continues to confirm their contamination with Salmonella.

Within the Animal Pathology Division, A Salmonella serotyping capability has been developed to meet Branch needs. Developmental research to support the division's diagnostic function is ongoing in the areas of phage-, bio- and plasmid-typing of Salmonella strains. Studies have also been conducted towards the development of a non-pathogenic Salmonella vaccine for calves.

A limited survey was sponsored to determine the prevalence, incidence, geographic distribution, antibiotic sensitivity patterns and
plasmid profiles of *Salmonella* organisms isolated from humans and from milk filters on Ontario farms. Additionally, factors associated with the presence of the organisms in farm families and bulk milk supply were assessed.

The activities of the various components of the Salmonella Control Program have undergone an extensive review and the resultant report is nearing completion. It is anticipated that the recommendations from this review will impact upon the direction of Agriculture Canada's future Salmonella control efforts.

4. *Dr. G. W. Meyerholz*, Program Leader, Veterinary Medicine, Extension Service, USDA, reported on the results of the Ad Hoc Interagency Coordinating Committee composed of representatives from USDA-APHIS, FSIS, ARS, ES and FDA and Dr. Ed Mallinson, Chairman of the Extension-Education Subcommittee of the Committee on Salmonella. This Ad Hoc Committee strongly supports the development of audio-visual and other educational aids on biosecurity.

5. *Dr. Larry Davis*, National Renderers Association, reported on the Salmonella Reduction Program of the Animal Protein Producers Industry. A complete report will appear in the proceedings of this meeting. The organization is commended for their efforts to reduce recontamination of their products.

6. *Dr. Richard E. Pacer*, VS-APHIS-USDA reported on a cooperative interagency investigation of *S. newport* in cattle in California. This comprehensive report will be presented in the proceedings of this meeting.

7. *Dr. K. V. Nagaraia*, University of Minnesota, reported on the development of an ELISA system for the detection of *S. arizonae* infection in turkey breeding flocks. The results look very promising, but additional research is needed before the test can be fully evaluated. The paper will be published in the proceedings of AAVLD.

8. Committee Reports

A. Regulatory Programs

1. Production

   *Dr. I. L. Peterson*, Chairman of the Subcommittee, reported that **31 states** are designated as U.S. Pullorum-Typhoid Clean and 5 additional states are in the process of qualifying.

   The model state program on biosecurity will be published in the next revision of National Poultry Improvement Plan.

   There were no cases of fowl typhoid detected in the past year. However, there were **71 cases** of pullorum disease in chickens reported in 1986 to date. These cases were traced to infections
REPORT OF THE COMMITTEE

arising from three hatcheries in two states and 7 unknown sources. One or more cases were detected in 21 states. Also two cases were detected in non-commercial flocks of turkeys.

2. Processing

Dr. W. H. Dubbert, Chairman of the Subcommittee reported that Food Safety Inspection Branch, USDA, is concerned about the continuing incidence of human disease caused by food-borne microorganisms such as Salmonella and other enteric bacteria. The agency is proposing a program to improve the microbiological quality of raw meat and poultry through the use of voluntary microbiological standards. This concept was supported by the recent report of the National Research Council. In order to meet the voluntary standards, some plants may have to implement technical processes or improve quality control programs to enhance sanitation and control bacterial contamination. Plants which produce raw meat or poultry that meet the voluntary standards on a continuing basis would be permitted to use special labeling to inform consumers of that fact. FSIS is also securing Salmonella benchmarked data on rendered animal by-products as they leave packer rendering establishments. The program, started in December 1985, indicates 26% of the 677 samples analyzed contained salmonellas.

B. Industry

1. Feeds and Feed Ingredients

Dr. K. V. Nagaraja, member of the Subcommittee, reported the results of salmonella analysis of animal by-products used in three large turkey feed operations. Some sources of animal by-products had high frequency of salmonella recontamination whereas products from other suppliers had infrequent recontamination.

C. Research

2. Poultry

Dr. G. H. Snoeyenbos, Chairman of the Subcommittee reported that salmonella research at the University of Minnesota was directed at developing and testing cellular protein extracts for prophylactic immunization against S. gallinarum. Laboratory studies were very encouraging and field trials are underway in Morocco. A phage typing system for S. hadar was developed. A corroborative study is underway with NVSL to develop and evaluate an ELISA test for pullorum-typhoid.

Preliminary studies at Massachusetts were reported in strains of S. enteritidis and of S. arizonae which were particularly virulent for chicks. All such strains were of foreign origin.

400
SALMONELLA

D. Extension-Education

Dr. E. T. Mallinson, Chairman of the Subcommittee reported on the efforts of the Ad Hoc Interagency Coordinating Committee towards development of action video tapes on biosecurity. Dr. George W. Meyerholz is to be commended for his effective leadership of the Ad Hoc Committee and for progress towards information systems that address the needs for education and disease prevention in the livestock and poultry industries.

A cooperative interagency-industry educational program is viewed by this subcommittee as beneficial not only because of its potential effect on salmonella, but also for its anticipated impact on many other serious infectious diseases.

The subcommittee suggests that the Ad Hoc Committee should invite direct poultry industry participation in the development of this educational program and further, because the committee will be engaged in literally marketing or selling disease prevention, it should also obtain the services and guidance of a professional, commercial marketing specialist to outline and critique the program's basic strategies.

RESPONSE BY USDA TO RESOLUTION PASSED AT THE 1985 USAHA MEETING

1. The resolution concerned an increase in the Poultry Disease Budget of USDA-APHIS-VS to allow Federal Veterinary Medical Officers at the state level to be involved in field investigations of avian diseases and to allow restaffing of Regional Poultry Epidemiologists. USDA response was that APHIS-VS has limited funds available for poultry disease investigations. Due to budgetary constraints, however, funds allocated for that purpose are not likely to be increased. Veterinary Services is again training epidemiologists, one of whom will be assigned to poultry diseases. Additional training courses scheduled to be held this year to train field Veterinary Medical Officers in poultry diseases and to acquaint them with the industry. Further, Veterinary Medical Officers are expected to exercise a greater role in investigation of poultry diseases.

COMMITTEE ACTION ON TWO PROPOSED RESOLUTIONS

1. This resolution deals with the request that Government Agencies including ES, APHIS, ARS, CSRS, FSIS and FDA make available a sum of $40,000 to $60,000 to support, in cooperation with the poultry industry for the development of action video tapes demonstrating sound biosecurity practices and providing a basic understanding of their rationale and economic advantages.

2. This resolution deals with the request that FDA and USDA (ARS,
REPORT OF THE COMMITTEE

CSRS, APHIS, FSIS and ES) increase their educational, research and epidemiological efforts through their inhouse research programs as well as the competitive grants and special grant programs in reducing salmonella infections in livestock and poultry and contamination of meat and poultry products. Also to improve sanitation and processing procedures by investigating in cooperation with the Animal Protein Producers Industry to reduce salmonella recontamination in rendering plants and in animal and poultry by-products.

SUBCOMMITTEE ASSIGNMENTS FOR 1986

A. Diagnostics, Data Collection and Epidemiology
   C. D. Murphy, Chairman, Blackburn, Carpenter, Cole, Glock, Grass, Hird, Johnson, Kadel, McCain, McDonough, Nagaraja, Pacer, Potter, Robinson, Rosenstein, Schwartz, Sutch, Van Steenberg, Vorhies, Welsh

B. Regulatory Programs
   2. Processing — W. H. Dubbert, Chairman, Crandall, Kennedy, King, Kolb, Menning, Vezey.

C. Industry
   1. Feed and Feed Ingredients
      B. S. Pomeroy, Chairman, Beard, Bisplinghoff, Crandall, Dubbert, Davis, Fields, Grass, Kennedy, King, Kolb, Nagaraja, Peterson, Robinson, Snoeyenbos, Vezey.
   2. Poultry Breeders
      C. R. Weston, Chairman, Grass, Halvorson, Johnson, Nagaraja, Peterson, Kolb, Tramel, Snoeyenbos, Vezey.
   3. Livestock Industry

D. Research
   1. Poultry, G. H. Snoeyenbos, Chairman, Beard, King, Nagaraja, Weston.
   3. Cattle and Small Ruminants
      R. A. Robinson, Chairman, Glock, Hird, King, Van Steenberg, Vorhies, Welsh.
SALMONELLA

E. Extension — Education
   E. T. Mallinson, Chairman, Carpenter, Crandall, Dubbert, Davis, Fields, Halvorson, Grass, Kennedy, King, Kolb, Meyerholz, Potter, Rosenstein, Schwartz, Tramel, Vezey.

F. Ex-officio — W. B. Bixler
BROADENED GEOGRAPHIC RANGE AND PERIODS OF TRANSMISSION FOR NEMATODIRUS BATTUS IN THE UNITED STATES


Introduction

In 1985 the report to the Animal Parasitology Institute (API) and the Animal and Plant Health Inspection Service (APHIS) of the occurrence of Nematodirus battus in Oregon represented the first record of this nematode in the Western Hemisphere.1 The presence of N. battus, one of few helminths listed as an agent of foreign animal disease in the United States, constituted a unique situation for the scientific community and APHIS. The unexpected discovery of this nematode in North America in conjunction with an unusual life cycle in which clinical disease in populations of sheep may be delayed for extended periods following introduction into a new geographic area has created a real problem of acceptance for the potential impact of N. battus.

Preliminary research at the College of Veterinary Medicine at Oregon State University (CVM, OSU) resulted in recommendations at the general session of the 1985 USAHA for the development of programs for the surveillance and control of N. battus as well as three resolutions (Resolutions 16, 17, 19). Through 1985 and early 1986 limited surveys, epizootiological studies, and anthelmintic trials involving N. battus were conducted by personnel at CVM. Investigators at API and CVM cooperated with APHIS in developing sampling and survey procedures. In December, 1985, APHIS initiated an ongoing survey (including intestinal and fecal specimens) with the submission of samples to the National Veterinary Services Laboratories (NVSL) at Ames, Iowa, for identification. Although examination of intestinal samples results in more accurate diagnosis, logistics of submitting small intestines and contents and the subsequent recovery and identification of nematodes made it obvious that the samples for survey purposes had to be restricted to fecal specimens. Therefore the nationwide survey has essentially been based on the latter.

Information presented here includes a summary of survey data, inclusive of 27 September 1986, from research at the CVM-OSU and APHIS/

---

a College of Veterinary Medicine  
Oregon State University  
Corvallis, OR 97331

b USDA, APHIS, VS  
Hyattsville, MD

c National Veterinary Services Laboratories, USDA, APHIS  
Ames, IA

d USDA, APHIS, VS  
Salem, OR 97301
BROADENED GEOGRAPHIC RANGE

NVSL. These data documented the ability of combined and cooperative efforts of university, USDA-APHIS/NVSL, and the animal health industry to begin to follow USAHA recommendations to meet a potential emerging disease problem. Expanded geographic and host ranges for *N. battus* and preliminary results of epizootiological studies and anthelmintic trials are documented. New evidence is presented that supports an hypothesis for the recent introduction of *N. battus* in the United States. These data demonstrate the need for continued surveillance programs. However, even more important, the collective data show a critical need as described below for epizootiological studies to provide information necessary for integrated measures to control this foreign animal disease agent.

**Surveys**

In the early spring of 1985 the CVM began selectively examining small intestines and fecal samples from sheep in Oregon to determine the presence of *N. battus*. Initially, sampling conducted by CVM personnel and later by the Oregon State Department of Agriculture (OSDA), was restricted to areas in Western Oregon, from Roseburg north into the Willamette Valley and west to the Oregon coast. Collections were later extended into Eastern Oregon (essentially to the Idaho border) including a feedlot at Pendleton, Oregon. Fecal specimens acquired at the feedlot, all negative for *N. battus*, were from lambs originating in Washington, Utah, Idaho, and California. As of late 1985, the only positive samples were from the area of the Willamette Valley and the region of the Central Oregon coast (Figure 1). Through early 1986 CVM had identified 7 infected flocks in Oregon. Included among these positive premises was a producer known to import and export sheep via Canada. Additionally, sheep from this producer have been shipped to 16 different states (trace-backs have yet to be completed).

Also during this time interval, the CVM cooperated with the API, NVSL, and APHIS in developing protocols for sampling and submission of specimens. In December, 1985, the first field samples from APHIS arrived at NVSL. An extensive nationwide surveillance program resulted in the submission of nearly 33,000 samples from 49 states (excluding Alaska), Puerto Rico, and the Virgin Islands to NVSL. Results of the combined surveys (OSU and APHIS/NVSL) are given in Table I, while the known geographic distribution of *N. battus* is depicted in Figures 1 and 2. Through September 1986, *N. battus* had been identified in sheep from Oregon, Washington, Maryland, New York, and Vermont.

In a subsample of 118 premises surveyed in Oregon by CVM and NVSL, *N. battus* was found at 24 sites (20%), other *Nematodirus* spp. at 85 (72%), while these congeners occurred together at 16 (14%) localities. Although data for the distribution of *Nematodirus* spp. are not available for sites in Washington, the prevalence of *N. battus* was 15%. The similarity in the relative abundance of *N. battus* in Oregon and Washington may be an
additional indication of a limited and recent range for this nematode in the Pacific Northwest. This limited distributional pattern continues to suggest that this parasite has not been present in the United States for an extended period of time. The focus of infection in Oregon appears largely limited to Benton County and immediately adjacent areas. In the Pacific Northwest all positive sites are located west of the Cascade Mountains (except those at Prineville, Oregon). The record in Maryland represents an infected animal imported from Washington State. Detailed information on the history of infected animals in Vermont and New York is not yet available.

Among flocks known to be positive for *N. battus*, in which 10 or more animals were sampled, the prevalence of infection has ranged from 6–33% in Oregon and 3–32% in Washington. In comparison, the prevalence of this nematode in sheep from OSU in October, 1984 was 40%. It is uncertain whether the variation in prevalence observed among these sheep from Oregon and Washington has resulted from recent infection of animals or can be attributed to low-level chronic parasitism where hosts have developed a degree of resistance and detection is difficult. Epizootiological data will be required to adequately interpret results of surveys where seasonal variations in parasite abundance might be expected to influence the ability to detect both infected hosts and any real increases in parasite populations at specific localities.

Limited surveys of potential sylvatic hosts were negative. Although eggs of other *Nematodirus* spp. were present, those of *N. battus* were not found in four fecal specimens from *Cervus elaphus* and 17 from *Odocoileus hemionus* in an area where sheep were known to be infected with this nematode. Among other possible hosts, one of 135 fecal specimens from *Lama glama* was positive for *N. battus* in Oregon (Erno and Rickard, manuscript). The potential role of llamas in the distribution of *N. battus* is being investigated (Rickard and Erno, unpublished data).

The potential development of resistance to *N. battus* in sheep with infections of long duration suggests that the actual geographic distribution of this nematode cannot be accurately determined if surveys include a high proportion of chronically infected hosts. Consequently, it is recommended that active surveys in the future be initiated in the spring when the susceptible host population is dominated by naive lambs. It is suggested that young lambs be sampled during their initial 16 weeks of grazing.

**Epizootiology**

In late 1985 initial epizootiological studies were designed and initiated at the CVM. Pastures at the Veterinary Medical Isolation Facility (VMAIL), naturally contaminated with *N. battus*, were used in a program to provide preliminary information on the seasonality of transmission patterns of *N. battus* in Western Oregon. On a monthly basis, beginning in
November 1985, *N. battus*-naive lambs were allowed to graze for 4 weeks on the VMAIL pasture; at necropsy, parasites were recovered and identified. Transmission of *N. battus* during late fall conditions was indicated by infections in the initial sets of tracer lambs in November. Subsequent preliminary data (extending through mid-August, 1986) indicated a continuity in the life cycle of *N. battus* during all seasons of the year (CVM, unpublished data). The completion of the cycle of *N. battus* in the fall has only recently become a recognized phenomenon in Western Europe. However, uninterrupted transmission, possibly with the attenuation or absence of seasonally defined peaks of parasite abundance in the spring and fall, has not previously been observed.

As stated previously, in 1984 *N. battus* was present in 40% of the sheep examined and constituted only 23% of the total population of *Nematodirus* spp. In contrast, by 1985–1986, all animals grazed on the VMAIL pasture (locality of the original flock from 1984) became infected with *N. battus*, with this species now comprising 54–70% of the population of *Nematodirus* spp. It is not yet clear whether this indicates an actual shift in population structure of *Nematodirus* spp. on these pastures with *N. battus* becoming dominant following introduction to a new locality. Continued studies are required at this and other sites in the Pacific Northwest to confirm if the incidence and prevalence of *N. battus* are increasing and if it is becoming the predominant species of *Nematodirus*.

As a disease causing agent, *N. battus* has generally been associated with cooler, wet regions, such as the Northern British Isles and Norway. The environmental conditions throughout the currently known range of *N. battus* in the Pacific Northwest, and in Maryland, are somewhat comparable to those areas of Western Europe. Recently, *N. battus* was identified (NVSL) from samples from two unrelated premises near Prineville, Oregon (single lambs of 3 and 5 months in age, respectively). Prineville, at an elevation of 3,000 feet, is located in a high mountainous region approximately 50 miles east of the Cascade Mountains. Although precipitation is limited, extensive surface irrigation provides undetermined moisture. The cold atmospheric temperatures from fall to winter in this area of Oregon may be conducive to the spring bloom phenomenon as observed in Europe.

**Anthelmintics**

*Nematodirus battus* was not known, prior to 1985, to exist in the United States — thus no anthelmintics carried label approval for use against this parasite. Literature from Europe reported the efficacy of several ruminant anthelmintics, such as levamisole, fenbendazole and oxendazole, against *N. battus*; the efficacy of levamisole was 94% at 7.5 mg/kg whereas tetramisole was 97% to 98% effective at 15 mg/kg (label approval for sheep in the U.S. is 8 mg/kg). Fenbendazole, at 5 mg/kg (cleared dosage for cattle), and oxendazole were both 100% effective against both immature and mature *N. battus*.13,14
Concern by drug companies for the health of U.S. livestock was exemplified by their financial support to CVM-OSU for conducting anthelmintic efficacy trials. Ivermectin at 200 \( \mu g/kg \) (Merck & Co., Inc.), fenbendazole at 5 mg/kg (Hoechst-Roussel Agri-vet Co.), and levamisole at 8 mg/kg (American Cyanamid Co.) were shown to be from 91% to 100% effective against \( N. \) battus (Zimmerman et al., manuscript). Netobimin (Schering Corporation) is another anthelmintic with 100% efficacy against \( N. \) battus.\(^{15}\)

Use of such anthelmintic efficacy data must be combined with epizootiological data from yet-to-be-conducted studies if effective control methods are to be developed, recommended, and implemented.

**Summary and Recommendations**

Although \( Nematodirus \) battus is present in the United States, its distribution at this point in time appears to be limited to specific areas of the Pacific Northwest and the east coast. The distribution and prevalence patterns also continue to imply a recent introduction such that the population levels of this nematode have not increased to disease producing or clinically recognizable levels. Preliminary epizootiological data suggests that environmental conditions could allow the parasite population to increase.

Based on recent literature and preliminary observations in Oregon, recommendations were made to the 1985 USAHA relative to surveillance and control programs.\(^3\) Progress has been made in several areas as outlined in the present report. Information obtained from joint CVM-OSU and APHIS/NVSL efforts now demonstrates the following studies, listed in order of priority, must be initiated if control is to be realized:

1. Epizootiology — to determine the primary patterns of transmission:
   a. for timing of anthelmintic administration
   b. other management procedures to break the transmission cycle

2. Continued surveillance to sample during those seasons when the most susceptible host population is at a maximum (likely spring-time lambs).

We recognize the continued need for improved diagnostic tests, particularly rapid procedures, the establishment of monospecific infections, and studies in systematics to determine the relationship of populations of \( N. \) battus from the U.S. and those in Europe.

**Acknowledgments**

We acknowledge the efforts of the many APHIS personnel who have so far been involved in the collection and submission of samples from across the United States. In addition, we recognize the efforts of Dr. Michael Daly, Oregon State Department of Agriculture.

The willingness of so many producers to allow collection of samples from
their flocks demonstrates their concern for livestock health, the livestock industry, and their fellow producers. We appreciate the financial support from American Cyanamid Co., Hoechst-Roussel Agri-Vet Co., and Merck & Co., Inc. for conducting anthelmintic trials.

REFERENCES


Table I. Survey data from states with positive identification of *N. battus* as of 27 September 1986.

<table>
<thead>
<tr>
<th>State</th>
<th>No. of Specimens Received</th>
<th>No. Positive</th>
<th>No. of Premises Sampled</th>
<th>No. Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oregon(^a)</td>
<td>1360</td>
<td>64</td>
<td>145</td>
<td>24</td>
</tr>
<tr>
<td>Washington</td>
<td>1194</td>
<td>30</td>
<td>53</td>
<td>8</td>
</tr>
<tr>
<td>Vermont(^b)</td>
<td>29</td>
<td>NA(^b)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>New York(^b)</td>
<td>16</td>
<td>NA(^b)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Maryland</td>
<td>292</td>
<td>1</td>
<td>19</td>
<td>1(^c)</td>
</tr>
</tbody>
</table>

\(^a\)Includes original data from the College of Veterinary Medicine at Oregon State University and APHIS/NVSL.

\(^b\)Complete histories not available at the time of this writing.

\(^c\)This animal originated from the state of Washington.
Figure 1. Geographic range of *Nematodirus battus* in the Pacific Northwest. Asterisks denote localities where individual flocks are known to be infected with this nematode.
Figure 2. Geographic range of *Nematodirus battus* in the United States. Numbers indicate premises where *N. battus* had been identified, based on surveys by the NVSL and CVM, through September 1986. As of that date specimens from sheep in 49 states, Puerto Rico, and the U.S. Virgin Islands had been examined.
EMBRYO TRANSFER IN THE CONTROL OF TRANSMISSION OF SCRAPIE IN SHEEP AND GOATS

Warren C. Foote, M.S., Ph.D., Jay W. Call, D.V.M., M.S.,
Thomas D. Bunch, M.S., Ph.D., Utah State University, Logan, Utah
and Jack R. Pitcher, D.V.M., USDA, APHIS, VS, Mission, Texas

The Veterinary Services, APHIS, USDA and the Animal, Dairy and Veterinary Sciences Department, Utah State University, Logan, have been involved in research for over six years to develop and test embryo transfer procedures to determine the route of transmission of scrapie and to develop procedures to obtain scrapie free germ plasm of sheep and goats from scrapie infected flocks.

An extended period of time is required to conduct this work because of the very long period from exposure to onset of scrapie. This period has been established to be as long as five years or longer.

Two locations are being used to conduct the studies. One location is at the Scrapie Field Trial Laboratories, Mission, Texas, where scrapie dosed donors and recipients animals and their offspring are kept. The second location is at the Dugway Proving Ground, Dugway, Utah, where scrapie free donors and recipients and their offspring are kept. Both locations provide isolation to prevent exposure to other flocks. A third facility is being developed at Utah State University, Logan, Utah to establish scrapie free flocks from scrapie infected flocks and areas.

The use of embryo transfer to interrupt transmission of scrapie involves transmission during the process of reproduction (from fertilization through embryo and fetal development, in utero, to the initiation of parturition). This is referred to as vertical transmission as opposed to lateral transmission in which scrapie is transmitted among cohorts.

Three sets of experiments involving embryo transfer are being conducted; (1) embryo transfer in sheep with artificially induced scrapie, (2) embryo transfer in goats with artificially induced scrapie, and (3) embryo transfer in sheep with naturally occurring scrapie from U.S. flocks. An additional set of experiments is being considered to transfer embryos from donor sheep and goats in scrapie infected countries into recipients in the U.S.

Preliminary results are available from the first set of experiments. Work is underway in the second set of experiments and work in the third will begin when an appropriate opportunity with field scrapie in the U.S. becomes available.

All embryo transfers and subsequent births in the experiments dealing with artificially induced scrapie in sheep (set one) have been completed. The offspring are now being observed for the occurrence of scrapie. The experimental design for this set of experiments is shown in table 1. Embryo transfer groups were established to determine if scrapie is trans-
mitted vertically either at the time of fertilization or post fertilization in utero during the remainder of pregnancy. The absence of transmission at either of these times, and particularly at fertilization, would provide a procedure to obtain scrapie free embryos from scrapie infected parents. Embryos from scrapie dosed donors at Mission, Texas were transferred to scrapie free recipients at Dugway, Utah. This transfer determines if scrapie can be transmitted at the time of fertilization. Also embryos from scrapie free donors at Dugway, Utah, were transferred to scrapie dosed recipients at Mission, Texas to measure if transmission occurs in utero. The fetuses resulting from these transfers at Mission, Texas, were taken by Caesarean section to avoid exposure to lateral transmission.

Two additional groups were established as controls. One of these, referred to as negative controls, was developed at Dugway, Utah and involved embryos transferred from scrapie free donors to scrapie free recipients. Its purpose is to provide a check for the occurrence of non-experimental scrapie. The second, or positive control group, was developed at Mission, Texas by transferring embryos from scrapie dosed donors to scrapie dosed recipients with normal parturition and lateral exposure. This group measured the occurrence of the disease in the experimental system.

Results to date indicate that embryos can be transferred from scrapie dosed donors to scrapie free recipients without transmitting scrapie either at the time of fertilization or in utero during the ensuing pregnancy (table 2). The only offspring to contract scrapie thus far in the study were in the positive control group.

These preliminary results suggest that embryo transfer can be used to obtain scrapie free germ plasm from scrapie infected parents.

In addition to the embryo transfer results, a small number of offspring have been produced by artificial insemination of scrapie free ewes with semen from scrapie infected sires. The oldest of these offspring are 36 months of age. None of these animals have contracted scrapie to date suggesting that scrapie may not be transmitted through the semen.

These results, using embryo transfer when fully verified, can provide a protocol to import scrapie free germ plasm (embryos) from countries where scrapie exists, to salvage genetic material from infected flocks in the U.S., and to provide alternatives for assisting the control and eventual eradication of the disease from the U.S.

Based on our results to date and on information available on other species for other diseases, and also considering recommended procedures for donors, recipient, and embryo handling, we are developing models or procedures for use with transport of sheep and goat germ plasm including importation.

Once procedures to import sheep and goats are developed and approved the next step is to import selected genotypes into the U.S. Such plans
include identification of genetic traits to be imported to strengthen the U.S. sheep and goat industries, the minimal levels of performance for these traits, the breeds or genetic types that best possess these traits, and the countries or areas of the world where they are available.

The primary purpose for this entire undertaking is to support the sheep and goat industries of the United States. Prior to its initiation, the scrapie program was presented to the National Wool Growers Committee dealing with health where it received full endorsement. Subsequently, it has been reported to the National Wool Growers Annual Meetings.

Many countries of the world want to import sheep and goats from the United States but cannot because of the presence of scrapie in the U.S. This greatly limits the sale of U.S. breeding stock abroad. Countries which have this interest and which are familiar and support our work using embryo transfer to obtain scrapie free germ plasm include Australia, New Zealand, Brazil, England and Israel.

The development of procedures for international movement of germ plasm of sheep and goats will strengthen these industries in the U.S. and also provide a larger international market of U.S. quality germ plasm, and in addition, will assist in improving production from sheep and goats worldwide.

We envision that imports will be used to strengthen existing breeds as well as to add additional breeds. It should be noted that sheep and goats can be imported routinely only from New Zealand, Australia and Canada after adhering to U.S. prescribed animal health procedures.
Table 1. Summary of experimental design of vertical transmission of scrapie project using embryo transfer.

<table>
<thead>
<tr>
<th>Donors</th>
<th>Location</th>
<th>Recipients</th>
<th>Location</th>
<th>Transmission route&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scrapie exposed</td>
<td>Mission</td>
<td>Scrapie free</td>
<td>Dugway</td>
<td>Via embryo</td>
</tr>
<tr>
<td>Scrapie free</td>
<td>Dugway</td>
<td>Scrapie exposed</td>
<td>Mission</td>
<td>Via uterus</td>
</tr>
<tr>
<td>Scrapie free</td>
<td>Dugway</td>
<td>Scrapie free</td>
<td>Dugway</td>
<td>Negative control</td>
</tr>
<tr>
<td>Scrapie exposed</td>
<td>Mission</td>
<td>Scrapie exposed</td>
<td>Mission</td>
<td>Positive control (embryo + uterus + lateral transmission)</td>
</tr>
</tbody>
</table>

<sup>1</sup>Positive control; Both donors and recipients were scrapie exposed and offspring were exposed during and following parturition and are used to establish presence of scrapie agent. Negative control; Both donors and recipients were scrapie free and are used to measure for non-experimental presence of scrapie agent.

Table 2. Summary of results to date of vertical transmission of scrapie project using embryo transfer.

<table>
<thead>
<tr>
<th>Transmission route</th>
<th>Location of Offspring</th>
<th>Breed</th>
<th>No.</th>
<th>Ages (Mo.)</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Via embryo</td>
<td>Dugway</td>
<td>Cheviot</td>
<td>22</td>
<td>57-69</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suffolk</td>
<td>47</td>
<td>28-52</td>
<td>–</td>
</tr>
<tr>
<td>Via uterus</td>
<td>Mission</td>
<td>Cheviot</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suffolk</td>
<td>15</td>
<td>28-41</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suffolk</td>
<td>11</td>
<td>7</td>
<td>–</td>
</tr>
<tr>
<td>Negative control</td>
<td>Dugway</td>
<td>Cheviot</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suffolk</td>
<td>31</td>
<td>28-52</td>
<td>–</td>
</tr>
<tr>
<td>Positive control</td>
<td>Mission</td>
<td>Cheviot</td>
<td>5</td>
<td>63</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suffolk</td>
<td>10</td>
<td>19-41</td>
<td>–</td>
</tr>
</tbody>
</table>

<sup>1</sup>Offspring alive September, 1986; + indicates that offspring were diagnosed with scrapie in that group and have been sacrificed. None of the offspring in remaining groups have demonstrated clinical scrapie.
REPORT OF THE COMMITTEE ON SHEEP AND GOATS

Chairman: Mrs. M. C. Howard, Sacramento, CA
Vice Chairman: Dr. J. R. Pitcher, McAllen, TX

Dr. J. A. Acree, CA; Dr. D. S. Adams, WA; Dr. A. A. Andersen, IA; Dr. M. H. Bairey, IA; Dr. W. W. Clark, MT; Dr. N. E. East, CA; Dr. L. C. Faulkner, OK; Dr. J. E. Fox, GA; Dr. J. S. Glenn, CA; Dr. J. R. Gorham, WA; Dr. R. F. Hall, GA; Mr. J. N. Huff, CO; Dr. M. M. Jochim, CO; Dr. L. M. Kennedy, VA; Dr. H. Kitchen, TN; Dr. W. A. Knapp, Jr., NC; Dr. L. L. Logan, NY; Dr. M. R. Marshall, UT; Dr. B. McGowan, CA; Mr. J. H. Niemi, SD; Dr. B. I. Osburn, CA; Dr. R. K. Pelant, AR; Dr. J. P. Quigley, GA; Dr. S. L. Reynolds, OR; Dr. M. D. Salmon, CO; Dr. J. A. Schmitz, NE; Dr. A. W. Smith, OR; Dr. D. H. Smith, WA; Dr. J. G. Songer, AZ; Dr. J. L. Stott, CA; Dr. P. H. Timm, CA; Mr. O. H. Timm, CA; Dr. P. R. Turner, TX; Dr. R. M. Wainwright, NY; Dr. H. W. Whitford, TX; Dr. G. L. Zimmerman, OR.

The Sheep and Goat Committee met at 1:30 P.M., Monday, October 20, 1986. There were eighteen members and forty-three guests for a total of sixty-one people in attendance.

The Committee met as requested by the President of USAHA to consider the business of the Committee and submits the following report.

Dr. Jerry Callis, discussing current bluetongue research, introduced Dr. Polly Roy, University of Alabama, who reported on her research to develop a subunit vaccine for bluetongue and diagnostic molecular probes for identification of bluetongue virus in infected cells. Preliminary studies have shown the feasibility of inserting BTV genome segment 2 into an insect virus which is then used to infect caterpillars. As the virus replicates in the caterpillar, large amounts of virus protein 2 are produced, and this protein has been used to stimulate neutralizing antibody in laboratory animals. Large animal studies have been proposed and Dr. Roy stated that a satisfactory vaccine for bluetongue can be on the market in one or two years. The diagnostic probes for identification of the virus are being tested in cooperation with scientists at NVSL, Ames, Iowa and ABADRL, Laramie, Wyoming.

Dr. Callis then discussed the possible re-assortment of gene segments during replication of bluetongue virus when multiple serotypes are involved.

Dr. Chester A. Gipson, Hyattsville, MD, reported on the history of scrapie in the United States and on the current scrapie program. Several problem areas have become apparent in the bloodline programs. Among these problem areas are: lack of industry commitment; lack of disease reporting; and lack of adequate flock records. Suggested solutions to these problems included: to better inform the industry; to redefine the animals to be depopulated; to consider restrictions on interstate movement of animals.
REPORT OF THE COMMITTEE

from scrapie affected flocks; to conduct a cost-benefit study of the program; and to review the program with industry, research and regulatory representation.

Dr. Warren C. Foote, Utah State University, presented a report on a project involving embryo transfer in the control of transmission of scrapie in sheep and goats.

This project was initiated over six years ago, and preliminary results indicate that embryos can be transferred from scrapie dosed donors to scrapie free recipients without transmitting scrapie either at the time of fertilization or in utero during the ensuing pregnancy.

Dr. Gary Zimmerman, Oregon State University, presented an update on the broadened geographic range and periods of transmission of Nematodirus battus in the Pacific Northwest.

Dr. Zimmerman reported that this parasite was first identified in the United States in an Oregon flock in 1985. A limited survey was conducted in Oregon by Oregon State University. APHIS joined the survey in late 1985. In the Spring of 1986, a nationwide survey for N. battus was conducted, resulting in submission of over 33,000 samples to National Veterinary Services Laboratories. This survey revealed forty positive samples distributed as follows: Oregon, 24; Washington, 8; Vermont, 5; New York, 2; and Maryland, 1 (this sample was from an animal reported to have been shipped from the State of Washington). Dr. Zimmerman reported that no clinical symptoms were reported to be associated with these infestations. Also, Dr. Zimmerman recommended that an epizootiological data base be established to help formulate the proper treatment program for controlling the parasite. It was suggested that llamas may be a host of N. battus. Three resolutions concerning N. battus were passed by the Committee.

Dr. Cleon Kimberling, Colorado State University, discussed Brucella ovis and the need for an approved test for use in breeding rams. The Committee adopted a resolution recommending approval of the ELISA test.

Dr. Paul B. Doby, Illinois Department of Agriculture, asked that the Sheep and Goat Committee of the USAHA give consideration to establishing a subcommittee that would work with the appropriate staff in USDA, APHIS, to develop a plan to determine if Brucella melletensis is present in the United States.

Dr. R. A. Robinson, University of Minnesota, discussed ovine progressive pneumonia (OPP) and caprine arthritis encephalitis (CAE). Included in the discussions were the following recommendations: use of an approved immunodiffusion test; a study of the prevalence of the two
diseases through NAHMS (National Animal Health Monitoring System), and development of criteria for designating a herd or flock free of disease.

The Committee was updated on the current status of last year's committee resolutions, and passed the four resolutions outlined earlier.
PREVALENCE OF MYCOBACTERIUM PARATUBERCULOSIS INFECTION IN CATTLE CULLED IN THE UNITED STATES

Ames, IA 50010

Paratuberculosis is a chronic intestinal infection of ruminants caused by the bacterium *Mycobacterium paratuberculosis*. The clinical condition associated with *M. paratuberculosis* infection is Johne's disease, and is characterized by chronic diarrhea and severe emaciation. Paratuberculosis is known to occur world-wide, and was once considered the most economically important disease to the cattle industry in Britain. The study reported here was conducted to estimate the prevalence of paratuberculosis in cattle culled in the United States.

Samples were collected from clinically normal cattle at 76 USDA-inspected cattle slaughterhouses in 32 states and Puerto Rico. *Mycobacterium paratuberculosis* was isolated from tissues of 119 of 7,540 cattle. The prevalence rates of bovine paratuberculosis were 1.6% overall, 2.9% in dairy cattle, and 0.8% in beef cattle. Of states submitting more than 100 samples, only Pennsylvania, Minnesota, and Texas has prevalence rates that differed significantly (*P* <0.01) from the 1.6% national prevalence rate (Fig. 1). Most samples from Pennsylvania and Minnesota were from dairy cattle, and when comparing the prevalence rates from these states with the 2.9% from dairy cattle, only Pennsylvania was significantly higher (*P*<0.01). Likewise, when the prevalence rate for Texas (0.7%) was compared with the 0.8% rate for beef cattle, there was no difference.

Although an estimate of the number of paratuberculosis cattle can be made, factors associated with paratuberculosis, such as mastitis, infertility, decreased milk production, loss of product sales, and quarantined herds, make it nearly impossible to accurately determine the economic impact. Estimates by other investigators indicate that paratuberculosis is very costly to the national cattle industry.
Fig. 1. Prevalence rate by state of *Mycobacterium paratuberculosis* isolated from the ileocecal lymph node in cattle culled. Only states from which at least 100 specimens were received are indicated. Numbers given are percent positive.
In fiscal year (FY) 1986 there was a total of 22 tuberculosis herds in the United States and Puerto Rico. Sixteen of these herds were infected and six were exposed. Nine herds were newly detected, four of which were infected, and five were exposed. All nine herds were depopulated. Thirteen herds were carried over from FY 1985. During this fiscal year, 12 herds were depopulated and 1 herd was released from quarantine through testing. Nine herds will be carried into FY 1987 and are located in Hawaii (1 herd), New Mexico (6 herds), and Texas (2 herds). Depopulation, voluntary slaughter, testing, and the Dairy Termination Program are planned to remove all infected and exposed animals from five of these nine herds. The four remaining herds will be dealt with through test and slaughter programs until released. This year’s total of 22 herds is made up of 10 beef herds and 12 dairy herds.

The four newly-found infected herds in FY 1986 were located in New Jersey, Puerto Rico, Louisiana, and California. The herd in New Jersey, an Accredited-Free State, was a group of long-horned cattle in a privately owned animal collection and tuberculosis was detected through regular slaughter. The beef herd in Louisiana was a community pasture herd whose owner did not agree to depopulation as an exposed herd in 1982 and had been found negative to herd tests until slaughter of a herd bull detected the disease this year. The two other infected premises were dairies. The herd in Puerto Rico was detected through regular slaughter, and the herd in California was being tested in preparation for export under the Dairy Termination Program administered by the Agricultural Stabilization and Conservation Service (ASCS). Louisiana, Puerto Rico, and California have also had other infected herds within the last 4 years.

The five exposed herds this year were all beef types. One was located in Virginia and related to an infected herd found last year. This was also the case in Louisiana where four exposed herds were related to an infected beef herd found last year.

Last year, a total of 30 tuberculosis herds was reported, one of which had already been reported in FY 1983 and FY 1984. Two outbreak areas were found in the continental United States. In addition, a task force was activated to identify and begin depopulation of all exposed cattle on the island of Molokai, Hawaii. Eradication efforts were continued in all three of these areas this year.

In the North Carolina-Virginia outbreak area (13 beef herds in FY
1985), there was one additional exposed beef herd located and depopulated in Virginia this year.

In the El Paso milk shed area of New Mexico and Texas (10 dairy premises in FY 1985), while no new herds were detected, all 10 were present in FY 1986 with the total quarantined premises decreased to 8 by the year's end. Unless new foci of infection are found, it is probable that all premises in the El Paso milk shed area will be released from quarantine in calendar year 1987.

In Figures 2 and 7 of this report, herds on the island of Molokai are indicated as one herd. All herds on that island were classified as exposed to tuberculosis and depopulation procedures were started in September 1985. Gross lesions of tuberculosis were found at slaughter this fiscal year in animals from the island's largest herd that had pastured animals on both ends of the island. There were approximately 233 herd owners on the island. One hundred ninety-two owners of approximately 1,056 animals had completed depopulation of their herds, including final submission of indemnity claims, by this fiscal year's end.

Approximately 750 head of cattle with 45-plus owners remained on the island at the end of September 1986. The initial cattle population of the island was approximately 9,500 head. Of this number, roughly 8,000 were owned by two ranching operations. Tuberculosis has been documented to have occurred on the island since 1940 in at least nine herds. The first infected herd in the current outbreak of tuberculosis on this island was detected in early 1983. A program of test and slaughter, with selected herd depopulation, followed until September 1985 when a decision was implemented to depopulate all cattle on the island as exposed to tuberculosis. Completion of depopulation efforts is anticipated early in FY 1987. Legal action has been taken by approximately 20 herd owners to obtain a restraining order and to cause cessation of action to depopulate their herds. A recent decision in a State court and a written order, dated September 24, 1986, favored the State's position to depopulate all cattle on the island. Appeal to the State's Supreme Court by the plaintiffs is resulting in additional delays to free the island of exposed cattle.

Figure 1 — In FY 1986, three States became Tuberculosis Accredited-Free. They were Alaska, March 28, 1986; Iowa, May 8, 1986; and Wisconsin, which regained Accredited-Free status on May 28, 1986, after a 2-year requalifying period. At the time of this report, two additional States have qualified — Missouri and Georgia — and final approval of Illinois is pending.

Figure 2 — There was a total of 22 tuberculosis herds in the United States this fiscal year. Newly-detected herds, both infected and exposed, were located in California, one infected herd; Louisiana, one infected and four exposed herds; New Jersey, one infected herd; Virginia, one exposed herd; and Puerto Rico, one infected herd. A total of nine herds was
HOSKER

identified this past fiscal year and all were depopulated. Thirteen herds were carried over from FY 1986 and were located in Hawaii, one infected and approximately 233 exposed herds; Kansas, one infected group of rodeo steers; Louisiana, one infected herd; New Mexico, six infected herds; and Texas, three infected and one exposed premises. The totals for each of the involved States in FY 1986 are represented in Figure 2.

Figure 3 — This pie graph shows how all of the 22 tuberculosis herds in existence in FY 1986 were located. Direct traceback from regular slaughter found seven herds. Three additional herds were located by tracing from these seven slaughter cases. The preceding three cases, plus four herds that had commingled with infected herds make up the seven herds located by tracing from affected herds.

Six herds were located by means of high-risk-area testing in the El Paso milk shed area of New Mexico and Texas. Two herds were detected by testing for international movement. One of these was the group of rodeo steers detected last fiscal year and depopulated this fiscal year. The other was a large dairy in California tested for export in connection with the Dairy Termination Program.

Figure 4 — This second pie graph illustrates only the nine herds newly identified this past fiscal year. Traceback from slaughter located one infected herd in each of the following States: Louisiana, New Jersey, and Puerto Rico. Testing for export located one infected herd in California. Tracing of exposed cattle accounted for four exposed herds in Louisiana and one exposed herd in Virginia. The herd in Virginia had received a lesioned-exposed animal that had originated from an infected herd found last fiscal year in Virginia.

Figure 5 — Epidemiological tracing accounts for 14 of the 22 herds identified in FY 1986 and includes slaughter and traceback herds, traceback exposed herds that have commingled with infected herds. Of eight herds detected through tuberculosis testing, one in Kansas and one in California were identified by required testing for international movement. The other six herds were detected because of special area testing in the El Paso milk shed area and, in truth, were tested as part of the epidemiology of that outbreak.

Figure 6 — Twelve of 22 tuberculosis herds identified in FY 1986 were depopulated. Two of the 12 herds were depopulated through assistance from the Dairy Termination Program. One Texas herd on a test and slaughter program was released from quarantine this year. Five of the nine herds remaining are expected to be depopulated in FY 1987. Four of these herds will be depopulated through a combination of the Dairy Termination Program, which involves only female animals, plus voluntary slaughter by owners of steers and bulls. Depopulation of exposed cattle from the island of Molokai should be completed in early FY 1987. Four herds in the El Paso milk shed area are under a test and slaughter
program and based on recent test findings may be released from State quarantine early next year.

**Figure 7** — This figure illustrates the location of tuberculosis herds and the numbers depopulated in each of the involved States. As previously indicated, all cattle on the island of Molokai, Hawaii, are classified as exposed.

**Figure 8** — These bar graphs illustrate the outcome of 31 slaughter and traceback cases that were completed during FY 1986. Three out of four cases (75 percent) represented identified adult animals that were successfully traced. One identified steer and 27 unidentified steers were not traced to a herd of origin. The value of animal identification, in combination with submitted slaughter samples, is very apparent.

**Figure 9** — This line graph shows the monthly fluctuations in the 1,591 submissions of tuberculosis-suspicious tissue samples from Federally-inspected slaughter houses.

**Figure 10** — The total number of tuberculosis-suspicious samples submitted in FY 1986 was 1,723 of which 132 were submitted by State-inspected slaughter plants. There was a total of 2,294 tuberculosis-suspicious samples submitted in FY 1985. This decrease of 571 samples is related to a decreased importation of Mexican feeder steers in FY 1985, which was approximately 180,000 head as compared to approximately 440,000 head imported in FY 1984. These animals spend approximately 1 year on pasture and in feedlots before being slaughtered. There were 40 cases determined to be compatible for tuberculosis and sent to the field for traceback and investigation. This is about 40 percent of the cases investigated last fiscal year. The 40 cases represent 34 feeder animals and 6 adult cattle. Successful tracebacks were completed in four of the six adult animal cases, one of which led to a source in Canada. Two of these adult animal cases are under continuing investigation at the fiscal year's end.

**Figure 11** — A total of 24 bison herds has been confirmed as infected with bovine tuberculosis since 1984. This includes 2 herds initially detected in FY 1984 and 22 herds subsequently detected from shipments of infected animals from these 2 herds. The first herd found in the outbreak of tuberculosis in bison was detected by submission of a suspicious tissue from a regular slaughter animal in April 1984. One herd in Kansas was depopulated in January 1986 and it had received an infected bison out of one of the original infected herds.

Exposed bison in two other small herds were depopulated without gross lesions or laboratory evidence of infection. Continued surveillance through testing was accomplished this fiscal year in two small groups of bison whose owners had purchased exposed animals from South Dakota and had not agreed to depopulate.

The total number of tuberculosis herds detected in the last 2 fiscal years
(30 in 1985 and 22 in 1986) was high. However, only four of the newly-discovered nine herds were found to be infected. Thirteen herds had been identified during FY 1985. Of this number, 10 were in the El Paso milk shed area of New Mexico and Texas, and 1 was in Hawaii. The other two herds were located in Kansas and Louisiana. For FY’s 1986 and 1987, female dairy cattle from six quarantined premises were accepted by the Dairy Termination Program of ASCS. Exposed bulls and steers will be sent to slaughter without indemnity. Reactor animals discovered by required herd tests are eligible to receive Federal indemnity. The six infected herds, with four owners, are located in three States. The Dairy Termination Program buy-out for female cattle in these States must be accomplished as follows: California — one herd in FY 1986; New Mexico — two herds in FY 1986, and two herds in FY 1987; and Texas — one premises in FY 1986.

It is anticipated that all nine of the current carryover herds will have either been disposed of or released from quarantine early in FY 1987.

APPENDIX

TUBERCULOSIS CATTLE HERDS
BY STATE
FY 1986

<table>
<thead>
<tr>
<th>DETECTED IN FY 1985 AND EARLIER</th>
<th>ACTIVE IN FY 1986</th>
<th>CARRY-OVER INTO FY 1987</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>13 Infected</strong></td>
<td><strong>16 Infected</strong></td>
<td><strong>8 Infected</strong></td>
</tr>
<tr>
<td>Kansas</td>
<td>California</td>
<td><strong>2 New Mexico</strong></td>
</tr>
<tr>
<td>Louisiana</td>
<td>Kansas</td>
<td>*<strong>Texas</strong></td>
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<tr>
<td>* Hawaii</td>
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<td>** New Mexico</td>
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</tr>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td>***Texas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 Exposed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Louisiana</td>
<td>1 Exposed</td>
</tr>
<tr>
<td></td>
<td>***Texas</td>
<td>* Hawaii</td>
</tr>
<tr>
<td></td>
<td>Virginia</td>
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</table>

13 Herds                         22 Herds                       9 Herds

* Hawaii                           Infected and exposed Herds on Molokai Island, Hawaii
** New Mexico                      Infected Herds
                                             El Paso Milk Shed
***Texas                            Infected and Exposed Herds
                                             El Paso Milk Shed
Tuberculosis Eradication
Location of 22 Tuberculous Herds
FY 1986

*See text for explanation
Tuberculosis Eradication

Methods of Locating 22 Tuberculous Herds Under Surveillance During FY-86

- Traceback of Regular Kill Slaughter Animals (7)
- Tracing Exposed Cattle from Affected Herds (7)
- Test for Movement (2)
- High-Risk Area Test (6)
Tuberculosis Eradication

Methods of Locating 9 Newly Detected Tuberculous Herds During FY-86

- Traceback of Regular Kill Slaughter Animals (3)
- Test for Movement (1)
- Tracing Exposed Cattle from Affected Herds (5)
Detecting Herds with TB Infection: 1975 through 1986

![Graph showing the percentage of herds detected with TB infection from 1975 to 1986. The graph displays the trend over the years with different testing methods, including all other tuberculin testing and epidemiologic tracing.](image-url)
Tuberculosis Eradication

Herds Found vs. Herds Depopulated
FY 1977-86
Proportion of Tuberculous Herds Depopulated
FY 1986

*See text for explanation
Tuberculosis Eradication

Traceback of 31 Tuberculous Cases Closed
(Regular Kill Animals) FY 1986

27 Unidentified

100% Unsuccessful

4 Identified

25% Unsuccessful

75% Successful
Tuberculosis Eradication

Number of 6-35's Submitted FY 86
(Federal Establishments)

Number of 6-35's Submitted

Tuberculosis Eradication

Tuberculosis Traceback Investigations Submitted (Regular Kill) FY 1986

<table>
<thead>
<tr>
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<td>53</td>
<td>78</td>
<td>27</td>
<td>82</td>
<td>108</td>
<td>40</td>
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</tbody>
</table>

*(State & Federal Submissions)*
Bovine Tuberculosis in Bison—FY 84–FY 86

| States Receiving Tuberculosis Accreditied-Free Exposed Bison (24) |
| States Receiving Tuberculosis Exposed Bison (14) |

- Total Herds Infected (24)
- Herds Initially Infected (2)
- Herds Found Infected in Fiscal Year 1984 (16)
- Herd Found Infected in Fiscal Year 1985 (5)
- Herd Found Infected in Fiscal Year 1986 (1)

* States Receiving Tuberculosis Exposed Bison (24)
REPORT OF THE COMMITTEE ON TUBERCULOSIS
AND JOHNE'S DISEASE

Chairman: Dr. S. B. Hurley, Madison, WI
Vice Chairman: Dr. V. P. LaBranche, Boston, MA

Dr. J. N. Archer, MD; Dr. J. M. Arnoldi, WI; Dr. L. R. Barnes, IN; Dr. J. E. Davidson, NE; Dr. M. A. Essey, MD; Dr. G. H. Frye, MD; Dr. T. J. Hagerty, MN; Dr. S. K. Harris, IA; Ms. J. B. Hebbring, SD; Dr. B. R. Hillman, ID; Dr. E. M. Himes, IA; Dr. R. L. Hosker, MD; Dr. D. E. Hughes, SD; Dr. L. A. Elsken, IA; Dr. R. L. Jones, CO; Dr. C. L 'Ecuyer, Canada; Dr. A. R. McLaughlin, WI; Dr. A. M. Lewis-Hintz, IA; Dr. H. Lloyd, FL; Mr. R. S. Merkal, IA; Dr. M. E. Oetting, MO; Dr. W. J. Owen, IA; Dr. B. S. Perryman, NC; Dr. W. L. Searles, TX; Dr. R. C. Sexauer, WA; Dr. M. S. Silberman, GA; Dr. D. H. Smith, WA; Dr. P. L. Smith, CA; Dr. G. R. Snyder, VA; Dr. P. L. Spencer, MO; Dr. C. D. Stumpff, KS; Dr. C. O. Thoen, IA; Ms. Diana L. Whipple, IA; Dr. R. H. Whitlock, PA; Dr. B. Widger, NY; Mr. D. E. Hensel, CO.

The meeting was convened at 1:30 P.M., Tuesday, October 21, 1986, in the Loch Room of the Executive West Hotel in Louisville, Kentucky. Seventy-one members and guests were in attendance during the two day meeting.

Dr. David Bartlett began the afternoon session with a request from the bull stud industry that the committee re-evaluate the problem of Johne’s disease in bull studs in light of 1980's information and experience. A subcommittee will be appointed to examine this issue.

Dr. Morrie Craig briefly addressed the committee to introduce a recommendation from the Johne’s subcommittee that this subcommittee be granted full committee status. This will be discussed in more detail during the subcommittee report on Wednesday.

Dr. Larry Elsken gave a report on some of his work using guinea pigs to standardize mycobacterial P.P.D's. He was able to conclude that, while it is possible to compare and standardize the various tuberculins used for intradermal testing, the validity of the test for predicting the disease status of individual animals is questionable.

Diana Whipple presented a summary of the large scale Johne’s disease slaughter sampling project which was undertaken by the USDA. The text of her remarks will appear in the proceedings book.

Dr. Claude Lavigne of Agriculture Canada spoke briefly about the developing Johne’s disease program in Canada. Three hundred herds have been selected for a study which will compare the production records of Johne’s infected herds with herds which are not known to be infected. The information collected will be used to develop a cooperative industry: government control program.
TUBERCULOSIS AND JOHNE’S DISEASE

Dr. Charles Thoen presented information that had been collected during a study of experimental *M. bovis* infections in bison. His conclusions were that in bison dosed with live *M. bovis* via the trachea, the results of skin testing, both caudal fold and comparative cervical, were much the same as they would be in cattle. Other tests conducted such as ELISA and lymphoblastogenic assays also showed results comparable to those seen in cattle. The lesions at necropsy and on histopathology were typical of those found in cattle. Disease free domestic cattle placed in the pens with the tuberculous bison to study transmission were lesion free at the end of the study period and no *M. bovis* was isolated from any of the tissues. However, two of the calves had recently developed suspicious reactions on the caudal fold test and perhaps more time would have given a different picture.

Dr. John Gay gave a report on some studies he had conducted investigating the effects of fecal sample handling upon the results of fecal culturing for *M. paratuberculosis*. He found that refrigerated samples yielded better results than freezing which in turn yielded better results than samples stored at room temperature. Samples held for 24 hours were better than those held for five days which were better than those held for 14 days. When he looked at the number of tubes inoculated for culture of each fecal sample, he found that if three tubes gave a 100% chance of identifying *M. paratuberculosis*, then culturing only two tubes per sample would miss 10.5% of those positives and inoculating only one tube would diminish the chances of detecting a positive by 30.5%.

Dr. Charles Stumpff gave an update of the tuberculosis outbreak in the El Paso milkshed herds. Some of the herds have been depopulated through participation in the dairy herd buy out program while others remain and are being tested periodically. The source of the outbreak is not known with certainty, although one of the infected herds identified as “herd P” is the most likely source of infection for the others. Of three hundred farm laborers and their families tested on one of these farms, 49 were skin test positive and placed on treatment for tuberculosis.

Dr. Robert Whitlock reviewed some work which he has been involved in which attempts are being made to examine the role of environmental contamination with *M. paratuberculosis* in the epidemiology of Johne’s disease. In one instance on a premises housing a heavily diseased herd, four of eight soil samples from a heifer pasture were found to be positive for *M. paratuberculosis*. Other small scale isolated investigations have yielded negative results. Most recently, contamination problems have plagued a large scale study of this problem.

He has also been looking at the effects of fecal sample size and centrifugation upon the results of fecal culturing for *M. paratuberculosis*. Fecal samples ranging in size from .5 grams to 5 grams were cultured and it has been demonstrated that the percentage of positive samples increases from 26% when .5 grams is used to 64% when 5 grams is used. Centrifugation of
the samples increased the percent positive cultures when compared to sedimentation.

The Tuesday session was adjourned at 4:15 P.M.

The committee reconvened at 1:30 P.M. on Wednesday, October 22.

Dr. Calvin Lum, the State Veterinarian of Hawaii reported briefly that the problems with the tuberculosis eradication program had been resolved through the court system and all exposed cattle on the island of Molokai will be depopulated. The courts ruled that the entire population of the island could be considered as one herd based on exposure and that the State could depopulate this herd under its police powers. In all, approximately 9,500 head of cattle belonging to 233 owners will have been depopulated. A five year study conducted by the Southeastern Cooperative Wildlife Disease Study has indicated that tuberculosis is not maintained in the feral swine and axis deer populations.

Dr. Ralph Hosker then gave the status report on the State/Federal Tuberculosis eradication program. In fiscal year 1986 there was a total of 22 tuberculosis herds in the United States and Puerto Rico. Sixteen were infected and six exposed. The text of his remarks will be included in the proceedings book.

Dr. Charles Thoen presented a report on the use of an ELISA test for detecting *M. bovis* infected cattle. One of the objectives of the research was to minimize the response to other acid fast organisms. He also discussed a comparison of serologic tests for Johne's disease with fecal culturing. While ELISA testing was relatively consistent in this comparison for cattle sampled at slaughter, in an infected herd the ELISA test results were not clearly indicative of disease status.

Dr. Morrie Craig submitted the Johne's subcommittee report for approval by the committee. The subcommittee met on October 20. Various prevalence surveys were discussed as well as some of the epidemiology studies that have been conducted in various states. A recommendation was made that the Johne's and Tuberculosis Committee be divided into two committees. This recommendation was forwarded by the committee for consideration by Dr. Hudelson and the Executive Council. A resolution was approved.

Dr. Vic Nettles appeared before the committee to ask for advice concerning a section on testing exotic and wild animals for tuberculosis which will be included in a document being prepared by the Wildlife Diseases Committee.

Dr. Lowell Barnes gave the subcommittee report on international program recommendations for the control and eradication of bovine tuberculosis. The guidelines have been revised to emphasize the importance of slaughter surveillance, proper training, and the delineation of short and
long term goals in countries seeking to begin an eradication program. The report was accepted.

A resolution dealing specifically with tuberculosis in Mexican cattle moving into the United States was also approved and forwarded.

Dr. Ralph Hosker presented two amendments to the Uniform Methods and Rules. The first would add to section H Classification of Cattle Tested the paragraph:

"6. Reclassification of Animals — Animals responding to the caudal fold tuberculin test that are found negative or suspect to the C-C test shall be reclassified as reactors when included in a herd test following which bovine tuberculosis has been confirmed.

The second amendment adds to paragraph 3 of section Q Retest Schedules for High Risk Herds (Cattle) the portion of the sentence:

"If negative to the test, the exposed animals) will subsequently be handled as if a part of the herd of origin for purposes of testing, quarantine release and the five annual high-risk tests and the remainder of the herd shall be retested in 1 year with the caudal fold test.

Both amendments were approved for incorporation into the Uniform Methods and Rules.

The committee adjourned at 5:35 P.M.
91st ANNUAL MEETING
October 25–30, 1987
MARRIOTT HOTEL
Salt Lake City, Utah

92nd ANNUAL MEETING
October 16–21, 1988
EXCELSIOR HOTEL
Little Rock, Arkansas

93rd ANNUAL MEETING
October 22–27, 1989
RIVIERA HOTEL
Las Vegas, Nevada