Proceedings
FIFTIETH
ANNUAL MEETING
of the
UNITED STATES
LIVESTOCK SANITARY
ASSOCIATION

HOTEL STEVENS
Chicago, Illinois
December 4, 5, 6, 1946
Proceedings
FIFTIETH
ANNUAL MEETING
of the
UNITED STATES
LIVESTOCK SANITARY
ASSOCIATION

HOTEL STEVENS
Chicago, Illinois
December 4, 5, 6, 1946
# CONTENTS

President's Address by William Moore ........................................... 1
Welcome to Illinois. By Honorable Arnold P. Benson ....................... 7
Response to Welcome. By R. W. Smith ........................................ 9
Memorial Service. By J. L. Axby .............................................. 15
Experiences in the Control of Rabies in New York State. By A. Zeissig and R. F. Korns ................................................... 17
Continued Studies on Rabies Control in Maryland. By A. L. Brueckner ...... 37
Report of Committee on Biologies. By M. Welsh ............................. 43
Report of the Committee on Policy. By W. J. Butler .......................... 45
Report of Committee on Community Auction Sales. By D. C. Hyde .......... 46
Report of Committee on Legislation. By W. J. Miller ....................... 49
Report of the Committee on Anaplasmosis. By H. Schmidt .................... 50
No Visible Lesions in the Bovine, and Its Relation to Avian Tuberculosis. By C. E. Fidler .................................................. 54
Considerations in the Control of John's Disease. By H. W. Johnson ......... 60
Bovine Tuberculosis—Past, Present and Future. By J. A. Myers ............... 66
Report of Cooperative Tuberculosis Control Program. By E. Lash ............ 78
Report of the Committee on Tuberculosis. By W. A. Hagan .................... 80
The Diagnosis and Control of Cattle Mange and Scabies. By D. W. Baker .... 84
Livestock Parasite Problems in the Southeast. By L. E. Swanson .......... 91
Report of Committee on Parasitic Diseases. By B. Schwartz ................. 96
Crystal-Violet Hog-Cholera Vaccine. By C. G. Cole and R. R. Henley ....... 102
Report of Committee on Transmissible Diseases of Swine. By H. C. H. Kernkamp ......................................................... 109
The Effect of World War II on Meat and Milk Hygiene. By J. S. Koen .... 111
The Genesis of Bovine Udder Infection and Mastitis. By J. M. Murphy .... 119
The Effect of Form Variation on the Antigenic Behavior of S. Pullorum. By P. R. Edwards and D. W. Bruner ............................. 130
Discussion. By R. Gwatkin ................................................... 136
Studies on the Control of Fowl Typhoid. By W. J. Hall, A. D. MacDonald and D. H. Legenhausen .................................................. 139
Newcastle Disease in Minnesota. By R. Fenstermacher, B. S. Pomeroy and W. A. Malmquist ............................................ 151
Observations on the Spread of Newcastle Disease. By E. Jungherr and N. Terrell ....................................................... 158
What Industry Thinks of the Newcastle Disease Problem. By C. D. Carpenter. 172
The Present Status of Newcastle Disease in the United States. By H. W. Schoening ..................................................... 176
Report of Committee on Transmissible Diseases of Poultry. By E. Jungherr 187
Salmonellosis of Domestic Animals. By D. W. Bruner and P. R. Edwards 194
Estimating Livestock Losses. By A. V. Nordquist ................. 199
A Solid Foundation for Veterinary Science. By M. S. Shahan.................. 209
The Fate of One Half Grain Per Pound Body Weight of Seven Sulfonamides in
Seven Animal Species. By M. Welsh et al........................................ 213
The Use of Sulfamethazine in the Control of Certain Infectious Diseases of
Livestock. By W. T. S. Thorpe and E. J. Straley............................... 235
Report of the Committee on Miscellaneous Transmissible Diseases. By C. R.
Schroeder............................................................... 244
Livestock Disease Prevention and Control in Canada. By O. Hall........... 248
Brucellosis in Oregon. By S. Foster.................................................. 254
Brucellosis and Its Relation to the Production of Livestock. By W. L. Baird... 259
Bovine Brucellosis Research. By C. K. Mingle.................................. 265
Human Brucellosis. By W. W. Spink.................................................. 274
Report of the Cooperative Brucellosis Control and Eradication Program. By
B. T. Simms........................................................... 287
Report of Committee on Brucellosis. By R. W. Smith.......................... 294
Report of Committee on Laws and Regulations. By T. O. Brandenburg....... 295
Report of Committee on Resolutions. By J. V. Knapp.......................... 298
Report of the Auditing Committee. By J. V. Knapp, T. C. Green and J. R.
Snyder................................................................................. 301
Report of the Nominating Committee. By R. W. Smith......................... 302
Election and Induction of New Officers. By W. Moore.......................... 302
OFFICERS AND COMMITTEES—1947

PRESIDENT

WILL J. MILLER .......................................................... Topeka, Kansas

VICE-PRESIDENTS

J. V. KNAPP, First Vice-President ................................. Tallahassee, Florida
T. O. BRANDENBURG, Second Vice-President ................ Bismarck, North Dakota
C. P. BISHOP, Third Vice-President ............................ Harrisburg, Pennsylvania

SECRETARY-TREASURER

R. A. HENDERSHOTT .................................................... Trenton, New Jersey

ADVISORY COMMITTEE ON ANAPLASMOSIS

L. T. GILTNER, Chairman, Washington, D. C.
T. O. BOOTH, Fort Worth, Texas C. E. KORD, Nashville, Tennessee
R. R. DYKSTRA, Manhattan, Kansas W. W. ROSENBEERY, Oklahoma City,
A. H. GROTH, Auburn, Alabama Okla.
HUBERT SCHMIDT, College Station, Texas

COMMITTEE ON BIOLOGICS

MARK WELSH, Chairman, Ridgewood, New Jersey
R. A. MAYS, Columbia, South Carolina J. R. SNYDER, Lincoln, Nebraska
J. SCHNEIDER, Drexel Hill, Pennsylvania A. H. QUINN, Kansas City, Missouri
FRANK BREED, Lincoln, Nebraska

COMMITTEE ON BRUCELLOSIS

R. W. SMITH, Chairman, Concord, New Hampshire
HUGH CURRY, Jefferson City, Missouri A. K. KUTTLER, Washington, D. C.
C. R. DONHAM, Lafayette, Indiana G. RATHMAN, Topeka, Kansas
H. C. GIVENS, Richmond, Virginia J. TRAUM, Berkeley, California
RALPH WEST, St. Paul, Minnesota

SPECIAL COMMITTEE ON COMMUNITY AUCTION SALES

C. E. FIDLER, Chairman, Springfield, Illinois
G. E. BOTKIN, Indianapolis, Indiana WILLIAM MOORE, Raleigh, North Carolina
JUSTIN CASH, Kansas City, Missouri J. R. SNYDER, Lincoln, Nebraska
D. C. HYDE, Columbus, Ohio

COMMITTEE ON LAWS AND REGULATIONS

T. O. BRANDENBURG, Chairman, Bismarck, North Dakota
C. P. BISHOP, Harrisburg, Pennsylvania I. G. HOWE, Albany, New York
W. J. BUTLER, Helena, Montana J. V. KNAPP, Tallahassee, Florida
OFFICERS AND COMMITTEES

A. K. Carr, Alhambra, California  
C. T. Conklin, Brandon, Vermont  
T. C. Green, Charleston, West Virginia  
F. E. Mollin, Denver, Colorado  
Roy V. Swanson, Pocatello, Idaho  
Harry Linn, Des Moines, Iowa

COMMITTEE ON LEGISLATION

WILL J. MILLER, Chairman, Topeka, Kansas

T. O. Brandenburg, Bismarck, North Dakota  
R. A. Hendershott, Trenton, N. J.  
William Moore, Raleigh, N. Carolina

W. J. Butler, Helena, Montana  
B. T. Simms, Washington, D. C.

J. S. Campbell, Little Rock, Arkansas  
A. A. Smith, Sterling, Colorado

COMMITTEE ON MEAT AND MILK HYGIENE

A. R. Miller, Chairman, Washington, D. C.

C. S. Bryan, East Lansing, Michigan  
A. F. Schalk, Columbus, Ohio

L. D. Frederick, Chicago, Illinois  
L. J. Tompkins, Packanac Lake, N. Jersey

Orlan Hall, Ottawa, Canada

J. S. Koen, Storm Lake, Iowa  
E. H. Willers, Honolulu, T. H.

L. D. Frederick, Chicago, Illinois.

COMMITTEE ON MORBIDITY AND VITAL STATISTICS

C. R. Schroeder, Chairman, Pearl River, New York

F. G. Buzzell, Augusta, Maine  
L. M. Hurt, Los Angeles, California

R. E. Foote, Hartford, Connecticut  
R. C. Newton, Chicago, Illinois

G. H. Good, Cheyenne, Wyoming  
A. P. Schneider, Boise, Idaho

COMMITTEE ON PARASITIC DISEASES

Benjamin Schwartz, Chairman, Washington, D. C.

J. E. Ackert, Manhattan, Kansas  
P. A. Hawkins, East Lansing, Michigan

D. F. Eveleth, Fargo, North Dakota  
R. D. Turk, College Station, Texas

COMMITTEE ON POLICY

W. J. Butler, Chairman, Helena, Montana

H. C. Givens, Richmond, Virginia  
V. S. Larson, Madison, Wisconsin

J. G. Hardenbergh, Chicago, Illinois  
I. S. McAdory, Auburn, Alabama

R. W. Smith, Concord, New Hampshire

COMMITTEE ON RABIES

A. L. Brueckner, Chairman, Baltimore, Maryland

C. W. Bower, Topeka, Kansas  
H. N. Johnson, Princeton, New Jersey

R. A. Hendershott, Trenton, New Jersey  
C. E. Kord, Nashville, Tennessee

I. G. Howe, Albany, New York  
H. W. Schoening, Washington, D. C.

A. Zeissig, Ithaca, New York

COMMITTEE ON RESOLUTIONS

J. V. Knapp, Chairman, Tallahassee, Florida

D. M. Campbell, Chicago, Illinois  
H. A. Tripp, Olympia, Washington

R. S. Robinson, Pierre, South Dakota  
H. F. Wilkins, Helena, Montana
OFFICERS AND COMMITTEES

COMMITTEE ON TRANSMISSIBLE DISEASES OF POULTRY

CARL BRANDLY, Chairman, Madison, Wisconsin

F. R. BEAUDETTE, New Brunswick, New Jersey
J. P. DELAPLANE, Providence, R. I.
W. R. HINSHAW, Davis, California
ERWIN JUNGER, Storrs, Connecticut
H. E. MOSES, Lafayette, Indiana

T. C. BYERLY, Washington, D. C.
CHARLES CUNNINGHAM, East Lansing, Michigan

COMMITTEE ON TRANSMISSIBLE DISEASES OF SWINE

J. D. RAY, Chairman, Omaha, Nebraska

H. C. H. KERNKAMP, St. Paul, Minnesota
C. E. FIDLER, Springfield, Illinois
H. C. SIMMONS, Jackson, Mississippi
B. H. EDGINGTON, Reynoldsburg, Ohio

L. P. DOYLE, Lafayette, Indiana
R. FENSTERMACHER, St. Paul, Minnesota

COMMITTEE ON TUBERCULOSIS

RALPH WEST, Chairman, St. Paul, Minnesota

W. A. HAGAN, Ithaca, New York
C. E. FIDLER, Springfield, Illinois
WILLIAM FELDMAN, Rochester, Minnesota
R. M. GOW, Denver, Colorado

V. S. LARSON, Madison, Wisconsin
W. M. SHANNON, Boston, Massachusetts
J. TRAUM, Berkeley, California
A. K. KUTTLER, Washington, D. C.
HISTORICAL

Records of the early meetings of the Interstate Association of Livestock Sanitary Boards are very meager. The first meeting of the organization was held in Fort Worth, Texas, September 28-29, 1897, primarily to inspect a vat for dipping cattle and sheep that had been constructed in that city.

The name of the organization was changed at the 13th annual meeting held in Chicago, Ill., in 1909, to the United States Livestock Sanitary Association. All meetings since 1909 have been held in Chicago.

<table>
<thead>
<tr>
<th>Meetings</th>
<th>Date</th>
<th>Place</th>
<th>President</th>
<th>Secretary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sept. 28-29, 1897</td>
<td>Fort Worth, Tex.</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>2</td>
<td>1898</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>3</td>
<td>1899</td>
<td>Chicago, Ill.</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>4</td>
<td>1900</td>
<td>Louisville, Ky.</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>5</td>
<td>Oct. 8-9, 1901</td>
<td>Buffalo, N. Y.</td>
<td>E. P. Niles</td>
<td>F. T. Eisenman</td>
</tr>
<tr>
<td>7</td>
<td>Sept. 22, 1903</td>
<td>Denver, Colo.</td>
<td>W. E. Bolton</td>
<td>Hon. W. P. Smith</td>
</tr>
<tr>
<td>8</td>
<td>Aug. 23-25, 1904</td>
<td>St. Louis, Mo.</td>
<td>J. C. Norton</td>
<td>Hon. W. P. Smith</td>
</tr>
<tr>
<td>10</td>
<td>Sept. 16-17, 1907</td>
<td>Springfield, Ill.</td>
<td>M. M. Hawkins</td>
<td>S. H. Ward</td>
</tr>
<tr>
<td>13</td>
<td>Dec. 5-7, 1910</td>
<td>Chicago, Ill.</td>
<td>W. H. Dalrymple</td>
<td>C. E. Cotton</td>
</tr>
<tr>
<td>14</td>
<td>Dec. 6-8, 1911</td>
<td>Chicago, Ill.</td>
<td>Chas. E. Cotton</td>
<td>J. J. Ferguson</td>
</tr>
<tr>
<td>15</td>
<td>Dec. 5-6, 1912</td>
<td>Chicago, Ill.</td>
<td>John F. DeVine</td>
<td>J. J. Ferguson</td>
</tr>
<tr>
<td>16</td>
<td>Dec. 2-4, 1913</td>
<td>Chicago, Ill.</td>
<td>W. H. Dynevel</td>
<td>J. J. Ferguson</td>
</tr>
<tr>
<td>17</td>
<td>Feb. 16-18, 1914</td>
<td>Chicago, Ill.</td>
<td>Peter F. Bahnsen</td>
<td>J. J. Ferguson</td>
</tr>
<tr>
<td>19</td>
<td>Dec. 5-7, 1916</td>
<td>Chicago, Ill.</td>
<td>J. I. Gibson</td>
<td>J. J. Ferguson</td>
</tr>
<tr>
<td>20</td>
<td>Dec. 2-4, 1917</td>
<td>Chicago, Ill.</td>
<td>O. E. Dyson</td>
<td>J. J. Ferguson</td>
</tr>
<tr>
<td>21</td>
<td>Dec. 2-4, 1918</td>
<td>Chicago, Ill.</td>
<td>J. G. Wills</td>
<td>S. H. Ward</td>
</tr>
<tr>
<td>22</td>
<td>Dec. 1-2, 1919</td>
<td>Chicago, Ill.</td>
<td>M. Jacob</td>
<td>S. H. Ward</td>
</tr>
<tr>
<td>23</td>
<td>Nov. 29-30-Dec. 1, 1920</td>
<td>Chicago, Ill.</td>
<td>G. W. Dunphy</td>
<td>D. M. Campbell</td>
</tr>
<tr>
<td>24</td>
<td>Nov. 28-30-Dec. 1, 1921</td>
<td>Chicago, Ill.</td>
<td>S. F. Musselman</td>
<td>D. M. Campbell</td>
</tr>
<tr>
<td>25</td>
<td>Dec. 6-8, 1922</td>
<td>Chicago, Ill.</td>
<td>W. F. Crewe</td>
<td>Theo. A. Burnett</td>
</tr>
<tr>
<td>26</td>
<td>Dec. 2-4, 1923</td>
<td>Chicago, Ill.</td>
<td>T. E. Munce</td>
<td>Theo. A. Burnett</td>
</tr>
<tr>
<td>27</td>
<td>Dec. 3-5, 1924</td>
<td>Chicago, Ill.</td>
<td>W. J. Butler</td>
<td>O. E. Dyson</td>
</tr>
<tr>
<td>28</td>
<td>Dec. 2-4, 1925</td>
<td>Chicago, Ill.</td>
<td>J. G. Ferneyhough</td>
<td>O. E. Dyson</td>
</tr>
<tr>
<td>31</td>
<td>Dec. 2-4, 1928</td>
<td>Chicago, Ill.</td>
<td>L. Van Es</td>
<td>O. E. Dyson</td>
</tr>
<tr>
<td>32</td>
<td>Dec. 3-5, 1929</td>
<td>Chicago, Ill.</td>
<td>C. A. Cary</td>
<td>O. E. Dyson</td>
</tr>
<tr>
<td>33</td>
<td>Dec. 4-6, 1930</td>
<td>Chicago, Ill.</td>
<td>Chas G. Lamb</td>
<td>O. E. Dyson</td>
</tr>
<tr>
<td>34</td>
<td>Dec. 5-7, 1931</td>
<td>Chicago, Ill.</td>
<td>A. E. Wight</td>
<td>O. E. Dyson</td>
</tr>
</tbody>
</table>

* Information not available.
<table>
<thead>
<tr>
<th>Date</th>
<th>Year</th>
<th>City</th>
<th>Name</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov. 30-</td>
<td>1932</td>
<td>Chicago, Ill.</td>
<td>Peter Malcolm</td>
<td>O. E. Dyson</td>
</tr>
<tr>
<td>Dec. 6-8,</td>
<td>1934</td>
<td>Chicago, Ill.</td>
<td>T. E. Robinson</td>
<td>O. E. Dyson</td>
</tr>
<tr>
<td>Dec. 5-7,</td>
<td>1935</td>
<td>Chicago, Ill.</td>
<td>Edward Records</td>
<td>O. E. Dyson</td>
</tr>
<tr>
<td>Dec. 4-6,</td>
<td>1936</td>
<td>Chicago, Ill.</td>
<td>Walter Wisnicky</td>
<td>L. Enos Day</td>
</tr>
<tr>
<td>Dec. 2-4,</td>
<td>1937</td>
<td>Chicago, Ill.</td>
<td>R. W. Smith</td>
<td>L. Enos Day</td>
</tr>
<tr>
<td>Dec. 6-8,</td>
<td>1939</td>
<td>Chicago, Ill.</td>
<td>J. L. Axby</td>
<td>L. Enos Day</td>
</tr>
<tr>
<td>Dec. 4-6,</td>
<td>1940</td>
<td>Chicago, Ill.</td>
<td>H. D. Port</td>
<td>Mark Welsh</td>
</tr>
<tr>
<td>Dec. 3-5,</td>
<td>1941</td>
<td>Chicago, Ill.</td>
<td>E. A. Crossman</td>
<td>Mark Welsh</td>
</tr>
<tr>
<td>Dec. 2-4,</td>
<td>1942</td>
<td>Chicago, Ill.</td>
<td>I. S. McAdory</td>
<td>Mark Welsh</td>
</tr>
<tr>
<td>Dec. 6-8,</td>
<td>1944</td>
<td>Chicago, Ill.</td>
<td>J. M. Sutton</td>
<td>R. A. Hendershott</td>
</tr>
<tr>
<td>Dec. 5-7,</td>
<td>1945</td>
<td>Chicago, Ill.</td>
<td>C. U. Duckworth</td>
<td>R. A. Hendershott</td>
</tr>
<tr>
<td>Dec. 4-6,</td>
<td>1946</td>
<td>Chicago, Ill.</td>
<td>William Moore</td>
<td>R. A. Hendershott</td>
</tr>
</tbody>
</table>
ERRATUM

On Page 220.

Formulae should read,

\[
\text{CH}_3\text{CO-}\text{NH-}\begin{array}{c}
\text{S}\text{-}\text{N-R}
\end{array}
\]
PRESIDENT'S ADDRESS

U. S. LIVESTOCK SANITARY ASSOCIATION, CHICAGO, ILLINOIS,

DECEMBER 6-8, 1946

BY WM. MOORE, D.V.S.

I consider it a distinct honor to have been elected president of this great Association, especially to serve during 1946 which is the 50th Anniversary of the Association and to follow the long list of distinguished men who have served as president during these 50 years. I wish to take this opportunity to express again my appreciation to the membership of this Association for having conferred upon me the honor of being president this year.

Our Constitution does not require an address by the president, I believe, but since this is customary, I shall follow this custom and present some remarks and suggestions that I think are of importance. Appropriate arrangements have been made at this meeting to review some of the history and accomplishments of this Association during the 50 years of its existence, which have meant much to the Live Stock Industry and of which we are justly proud. During the past 50 years many changes have been made in the raising and marketing of livestock, especially during recent years. With modern means of transportation and marketing methods, livestock and poultry are being moved long distances and animal and poultry diseases that were at one time more or less isolated are now widespread notwithstanding the sanitary restrictions that have been imposed.

I ask your indulgence that I may review the past to some extent in order to emphasize some of the work ahead of us as I see it, with no attempt to place these in the order of their importance. These remarks will be largely my own personal opinion.

Animal Tuberculosis: It is not necessary for me to review the animal tuberculosis control program which has been carried out for the past 25 or 30 years since this group is familiar with this and many of you had an active part in conducting this program. The control of animal tuberculosis and the reducing of this disease in our live stock to a minimum was a great achievement and has been given wide spread praise by many who were in a position to realize the importance of such work.

This campaign required a tremendous amount of work and the expenditure of a large amount of funds and this was justified by the results accomplished. However, it should be kept in mind that while this disease has been greatly reduced, it has not been entirely eliminated and if we are to maintain the gains which have been made, we must constantly apply those measures which we know are necessary to keep this disease under control and prevent its spread. The records indicate that this work has been neglected during the war years largely on account of a lack of trained personnel and there has been a consequent increase in the incidence of the disease in our live stock.

We should bear in mind that the only practical method of detecting this disease
is by the proper application of the tuberculin test. The records further indicate that there has been a large amount of testing done but it would seem that too many herds have been neglected over a period of years which has resulted in the spread of this disease. Tuberculosis is not only an important live stock disease, but it is, also, of immense public health importance and we should renew our efforts in planning a program that will insure against the possible spread and increased prevalence of this disease in our live stock. The very capable committee on tuberculosis has given this matter very careful thought and study and are making their report and recommendations at this meeting. I sincerely hope that this may be the beginning of a renewed effort on the part of all concerned to control and reduce this disease.

**Brucellosis:** This Association has been largely responsible for formulating a program for the control of brucellosis by applying the information gained through scientific research. Considerable progress has been made in recent years in controlling this disease and we have obtained much valuable information as a result of this work. We now have a very reliable test for the detection of this disease and while the blood test does not give us all of the information that we would like, it is a very reliable and a useful diagnostic test.

This disease is recognized as being very wide spread and of great economic importance to our live stock industry, especially cattle and hogs. By the application of the agglutination test and the practice of good herd management, we have been able to establish many herds free from this disease and to maintain them as such. By the same methods we have been able to establish Bang's free areas. There have been so called “breaks,” disappointments and criticisms but this is to be expected with such a complex problem.

The introduction of Bang's vaccine strain 19, a few years ago which resulted from long and careful research work offered additional assistance when properly used in the control of this important disease. However, this vaccine has not always been used in a scientific manner and to some extent has interfered with the proper control of Bang's Disease. I think we should constantly keep in mind that Brucellosis is of great economic importance and that our ultimate objective must be the control and final elimination of this disease.

To those of you who believe that this disease cannot be eradicated, I would recommend that you read carefully the full history of the eradication of the cattle tick in the South. This disease producing parasite affected the cattle in 985 counties, an area of more than 725,000 square miles in the South, 40 years ago. The eradication of this parasite presented greater difficulties than have been met with in the eradication of any other live stock disease to date. Yet, these difficulties were met and the cattle tick has been practically eradicated from all of this area and it should be remembered that in the early days of this campaign research workers found that this disease could be prevented by vaccination which would have meant the keeping of the cattle tick. They wisely chose to eradicate the tick and along with it tick fever.

It has been said by some that it is impossible to maintain Bang's Disease free areas or accredited herds on account of the tremendous movement of cattle. If we are going to admit that this is true, then we must admit that we cannot control
any disease since the fundamental principle of the control of infectious and contagious diseases of live stock is based on maintaining quarantine for without quarantine, we cannot control any of the animal diseases and if we have reached the point where we cannot maintain quarantine, then it is our duty to appeal to all of those who are interested in the live stock industry for help in correcting this condition because we all agree that live stock diseases must be controlled if the industry is to exist and prosper.

I fully realize that with our modern methods of transportation and marketing it is more difficult to maintain quarantine than it was in the old days but I am of the opinion that this can be accomplished and it must be if we are to control animal diseases. I think we all recognize the value of Bang's vaccine for the control of Bang's Disease, when properly used but I am sure that no one with a knowledge of Brucellosis and of disease control could expect this vaccine to do the things that some have advocated. Articles appearing in many breed and other papers, many of them written by men not qualified to give advice in such matters, have done much harm to the control program and have led to confusion on the part of the livestock owner. I am convinced that this disease can be controlled by the information and proven methods which we now have and I am also convinced that it must be controlled and eventually eliminated.

We should not follow any plan of control unless such a plan has as its final aim the elimination of this disease from our livestock, keeping in mind that this is also a human disease of perhaps more importance than is now recognized, and that the disease is spread from animal to man. The control and elimination of Brucellosis is definitely the duty of those composing this Association.

**Swine Diseases:** This association over a long period of years has done much to disseminate valuable research information relating to swine diseases. Serum and virus are valuable immunizing agents against hog cholera yet this disease still causes enormous losses and hog cholera continues to be the most important swine disease. While there has been a considerable amount of research work done on other swine diseases, there remains much to be done since there are many diseases about which we do not have sufficient information to prevent enormous losses. I think we need additional research work which will be of practical value in the diagnosis of swine diseases which are often complicated with hog cholera.

There seems to be some confusion among the experts on swine diseases especially where complications exist, which result in a heavy loss to the swine grower. Intensive research should correct this to a large extent. Adequate and convenient laboratory facilities for the diagnosis of swine diseases are urgently needed it seems to me.

**Rabies:** This is a disease which does not cause losses as great as some other diseases yet it is a disease that affects both man and animals and is spread by animals. It is a disease that can be controlled by applying the scientific information that has been developed by research work. We have a vaccine that is highly effective and we know that this disease can be controlled by the proper use of this vaccine and quarantine measures. I am hopeful that the work that this Association is doing in cooperation with other organizations interested in this disease will in the near future lead to control of this disease.
Anaplasmosis: This disease is becoming rather wide spread and may become much more serious than it is now considered. A practical method of diagnosis, prevention and treatment is urgently needed and it is hoped that a continued increase of research work will enable us to work out a practical control program.

Mastitis: This is a disease that is causing enormous losses to the dairy industry and while there are programs for the control of this disease, the losses seem to continue. Much progress has been made in the detection and treatment of this disease yet we are urgently in need of research work which will result in more practical methods of diagnosis and more effective treatment.

Parasites of Live Stock: Although a great amount of work has been done in controlling internal parasites of live stock by applying scientific measures resulting from research work yet there is still an enormous loss from these parasites. It has been clearly demonstrated that much of this can be prevented by applying the scientific information which we now have and it would seem that a renewed program for the control of parasites is now in order.

Nutritional Diseases: Much information regarding nutrition has been developed in recent years by our research workers but there remains a tremendous amount of work to be done in connection with the prevention of nutritional diseases.

Poultry Diseases: It would seem that we have not made the same progress in the control of poultry diseases that has been made in the control of animal diseases notwithstanding that a tremendous amount of research work has been done along this line and we have had information, if properly applied, that would have been of great benefit in connection with this. The poultry industry has grown so rapidly in recent years and along with this growth has developed many diseases of great economic importance to such an extent that we apparently have not been able to keep up with them. You are all familiar with the situation that confronts us in reference to Newcastle disease. This disease has appeared in many states and is now one of the important problems of the poultry industry. A National Committee has been appointed to study this disease and make recommendations. This committee has held several meetings and is diligently working to provide the best methods for the control of Newcastle disease with the least interference to the poultry industry. Much research work is being done on this disease and much remains to be done.

National Poultry Improvement Plan: The control of pullorum disease has long been recognized as essential to a profitable poultry industry. The control of this disease was undertaken by a number of states many years ago and finally resulted in the adoption of the National Poultry Improvement Plan developed by the United States Bureau of Animal Industry which plan also includes breed improvement. Practically all of the states are now cooperating with the Bureau under this plan and great progress is being made in the control of pullorum disease and breed improvement. This program should be continued as it is vital to the poultry industry.

Since this involves the control of disease, and I believe it should include other poultry diseases, the program should be conducted by the livestock sanitary officials of the several states. This, I believe, is not the case in some states and I believe it is the function of this Association to look into this situation.
Biologics: This Association has always recognized the importance of controlling biologics that contain living organisms since this is highly important in the control of disease. In a number of instances we have recommended to the Secretary of Agriculture that necessary regulations for the control of these products be issued. At the suggestion of this Association, the Secretary of Agriculture in June 1941 promulgated Amendment 15 to BAI Order 276 which was to become effective January 1, 1942. This Amendment did not prohibit the sale or distribution of any biological product but did make it mandatory that the producers and distributors of viable biological products make a report to the Chief of United States Bureau of Animal Industry and to the Chief Live Stock Sanitary Official of the respective states whenever any of these products were consigned to residents within the state. The Amendment referred to never became effective because the Secretary of Agriculture on December 24, 1941 revoked that part of the Amendment pertaining to the shipping of these viable products. This Association should continue to urge the adoption of this Amendment and its enforcement.

Foot and Mouth Disease: Fortunately, we have not had an outbreak of foot and mouth disease in recent years notwithstanding that the disease is quite prevalent in many foreign countries where little effort was expended towards control during these war years. The Bureau of Animal Industry of the United States Department of Agriculture in cooperation with other agencies and the several states have done a most commendable job under very trying conditions in keeping foot and mouth disease and other diseases out of this country—thus, protecting our great live stock industry. Recent news articles have most unfairly criticized the successful efforts made to protect our live stock industry from foot and mouth disease. With our present meat situation an outbreak of foot and mouth disease would be a real calamity and one from which we might not be able to fully recover. I recommend that this Association at this meeting take appropriate action to correct the false and misleading statements that have been made and that the true status of the situation be given wide publicity.

Uniform Regulations: In 1944 this Association adopted uniform regulations for the interstate movement of live stock which were submitted by the committee on laws and regulations. These regulations were submitted to the several states and they were urged to adopt them with a view to making interstate regulations more uniform. These regulations need some revision and the committee will no doubt make recommendations regarding this at this meeting. I am glad to report that a large number of states have adopted these regulations and a number of states have them under consideration. I think it highly important that all states adopt these regulations as far as local conditions will permit since it is highly desirable that we have uniform regulations.

There has been some complaint that some practicing veterinarians are issuing health certificates, especially on cattle, that are not in accordance with the regulations of the state of destination, making health certificates at the direction of the shipper only. It is the duty of the practicing veterinarian to issue health certificates in accordance with the regulations of the state of destination regardless of what he may think of such regulations.
Meat Inspection: I am glad to report that Federal meat inspection was returned to the Bureau of Animal Industry on October 1, 1946. The Bureau, over a period of years, developed this into a most outstanding service that is a credit to the Bureau. Some progress in meat inspection has been made by a number of state yet this is a matter that is being neglected in many states. A good system of state meat inspection is of great value to the general public and the live stock industry and would also give much valuable information as to the occurrence of disease and should be seriously considered by all states that do not now have proper meat inspection.

Live Stock Markets: The establishment of live stock markets seems to be on the increase in many states and while they offer the live stock farmer a ready market for his surplus animals, they are also potential spreaders of live stock diseases. Many animals entering these markets are either diseased or have been exposed to disease and unless these markets are under strict veterinary supervision with proper laws and regulations, we may expect that they will continue to spread disease.

Vital Statistics: One of the most urgent needs at the present time in my opinion is a state-wide and a nation-wide system of gathering vital statistics on transmissible animal and poultry diseases if we are to properly control such diseases. I would respectfully refer you to the 1945 report of the Committee on Miscellaneous Transmissible Diseases of this Association and reports of the American Veterinary Medical Association concerning this. I think it is highly important that all associations and agencies interested in this matter should get together on a workable plan to take care of this.

Research: The success which we have had in controlling and eliminating contagious and infectious diseases of live stock and poultry have been a result of the application of scientific research and we should therefore urge additional research work on the diseases that are now encountered, especially those diseases for which there is at the present time no satisfactory diagnostic or preventative agent.

There are many other important livestock and poultry diseases that I have not referred to as time will not permit this. It is needless to say that we should continue our programs for the prevention and control of all livestock and poultry diseases since this is essential to the livestock and poultry industries.
WELCOME TO ILLINOIS

BY HON. ARNOLD P. BENSON

Mr. President, ladies and gentlemen attending the 50th annual meeting of the United States Livestock Sanitary Association: It is indeed a great pleasure to come as a representative of your host State, and express a hearty welcome to all of you to the State of Illinois.

At the very outset I want to express the regrets of Governor Dwight H. Green, who had hoped and planned to be here personally to greet you. When his schedule of commitments made it impossible for him to come, he asked me to tell you how happy we in the State of Illinois are to have you as our guests during the days of your 50th annual meeting, and to wish you a very successful meeting.

The Governor of Illinois, the Illinois Director of Agriculture and the people of our State generally, are profoundly conscious of the importance and significance of this series of meetings. The history of the progress of our great and free people, ever meeting the challenges of changing times and conditions, have no more thrilling story than the story of the fight to control infectious diseases in the livestock of our country. I feel a great pride in having had even remotely a part in this great organization and in the fight it has led against the ravages of disease in both animals and humans.

In view of the progress that has been made toward the protection of the state and national wealth, represented in our livestock and in the protection and conservation of human life throughout this and other states and nations, I hesitate to think of what the present, economic and health status might be had it not been for the diligent study and continuous efforts of this Association toward the recognition, control and eradication of livestock diseases.

The idealism of your service to mankind is expressed admirably in your Constitution. I have read that document and recall some of the purposes of your Association: To study livestock sanitary science. To disseminate information relating thereto. To unify laws, regulations, policies and methods for the prevention, control and eradication of transmissible diseases of livestock. To maintain coordination among livestock regulatory organizations, and to serve as a stabilizing factor among the livestock agencies.

Briefly, it is my feeling that this Association has thus ordained itself to be a guardian of the security of the nation.

We in Illinois feel the great importance of our agriculture. We are keenly aware of the importance and relationship of the various agricultural projects. We recognize fully the dependency of agriculture upon the successful functioning of our livestock industry. The security of the agricultural investment, the security of the health and of the homes of the people of our State, are dependent upon the protection afforded against disease. The past and present generations have depended upon healthy livestock for food, clothing and other necessities of life. That will be increasingly true of future generations. Indeed, the livestock industry is indispensable in our economic and cultural progress.
The livestock industry of the State of Illinois represents a great investment in cattle, swine, poultry and sheep. The present market value of these animals represents indeed great wealth. The milk and meat, the food products obtained from these animals, thanks to the protective efforts of this Association, are wholesome and abundant. The contribution this Association has made toward human health cannot be measured in dollars and cents in the way we measure the economic value of healthy livestock. It is one of the great intangible services of our day.

Let us consider tuberculosis, for instance. In purely dollars and cents terms, in the United States the condemned carcasses of cattle have been reduced from 47,000 in 1917 to 1,200 in 1945, a reduction of over 45,000 cattle, which in 1945 represented a gain in wealth of approximately a half million dollars over 1917.

This gain being based on slaughter and meat value only does not include the gain represented in the increased amount of milk and dairy products obtained from these cattle. With this striking reduction of tuberculosis in our cattle, and the resulting economic gain, we have had a reduction in the loss of human lives.

Before the achievement of this great reduction in tuberculosis, scores of people in Illinois died as a result of drinking raw milk from infected cows. Before the establishment of the program for the control of tuberculosis in cattle, it was not uncommon for tuberculosis to claim annually the lives of 450 children under four years of age. Recent records show this number to be less than one-third of that number.

The most significant and gratifying aspect of this tuberculosis eradication in Illinois is that the created benefit is represented in the protection and preservation of human life. All of this could not have been accomplished without a diligent, humanitarian influence of the United States Livestock Sanitary Association.

The diseases of livestock represent the constant menace and threat to the security of our physical and economic wellbeing, and at this time, amid the devastation left by the war, we sense an increasing responsibility in providing food to persons in war-stricken countries all over the world. We feel an increased responsibility in safeguarding the public health and protecting the food supply of this and other nations. To do this the diseases of livestock must be held to a minimum.

I am confident that the members of this Association stand ready to assume this great responsibility. Fully mindful of the great accomplishments of this Association over the past half-century, I am certain and confident that the minutes of this meeting will record efforts toward the future protection of the wealth and health of the people of our nation. It is then a great privilege and a great pleasure for me to extend to you a most sincere and cordial welcome. (Applause)
RESPONSE TO WELCOME

BY DR. R. W. SMITH

Mr. President, you certainly are running things on schedule! (Laughter)

Director Benson and members of the United States Livestock Sanitary Association, invited guests and friends: As we are gathered here this morning at the opening of the 50th annual convention of this Association, it seems very fitting that the Director of Agriculture of the great State of Illinois should bring to us the official greeting of His Excellency, Governor Green. We know of the great demands made upon the time of our governors and our directors of agriculture, and because we do know this we all the more appreciate your being present with us this morning, sir.

Your warm greeting and inspiring message will give added energy to the men meeting here to carry on the fight against one of the worst enemies of the livestock industry today.

In any man's language, agriculture is the No. 1 industry of the world, and livestock are the foundation of America's great agricultural wealth. Upon agriculture every human being constantly depends. The wheels of industry would soon stop, and the lights of our factories would grow dim—yes, the great city of Chicago, with its millions of people, would soon become a ghost town should the agricultural industry of our country fail.

So I say to you men who have gathered here this week, whether you be farmers or livestock growers or packers or veterinarians or sanitary officers, or in any way interested in the promotion of the livestock industry of our country, your task is most important.

Somewhere, some time, I don't know just where, I picked up a few lines that I would like to read to you. I ponder these when I get a little low. It is entitled, "I Am A Farmer:

"I am the provider of all mankind. Upon me every human being constantly depends. The world itself is built upon my toil, my products, my honesty. Because of my industry, America, my country, leads the world. Her prosperity is maintained by me. Her great commerce is the work of my good hands. Her balance of trade springs from furrows of my farm.

"My reaper brings food for today; my plows hold promise for tomorrow. In war I am absolute; in peace I am indispensable, my country's surest defense and constant reliance.

"I am the very soul of America, the hope of the race, the balancewheel of civilization. When I prosper men are happy; when I fail all the world suffers. I live with nature, walk in green fields under the golden sunlight, out in the great alone, where brain and brawn and toil supply man's primary needs, and I try to do my humble part to carry out the great plan of God.

"Even the birds are my companions. They greet me with a symphony at the new day's dawn, and sing with me until the evening prayer is said. If it were not for me the treasuries of the earth would remain securely locked, the graineries would be useless frames. Man himself would be doomed speedily to extinction or decay."
Gentlemen, perhaps we are not farmers, but we are so closely allied with the greatest of all industries that when we meet here in convention during the first week in December of each year, and consider the serious problems that do confront the farmers of our nation and the greatest industry on earth, it certainly does us good, Director Benson, to have you, representing the Chief Executive of Illinois, and one of the greatest agricultural states in our country, come here and give us an inspiring message and a friendly greeting to your State and your city.

Many of us arrived Monday morning. We have all been in session for two days, discussing problems of this nature. Director Benson, I want to say to you that these two days were made very enjoyable because your lieutenant, Dr. Fidler, arranged for us yesterday a very pleasant day at the Swift & Company plant. It was not only pleasant but profitable to all of us. He also arranged for us to attend the Stock Show, where we visited and took a great deal of interest in your State exhibit.

And so, on behalf of the members of this Association, again I wish to thank you for coming to us this morning. We appreciate it, and I know that every individual here appreciates it.

Thank you.
THE HISTORY OF THE ORGANIZATION OF THE UNITED STATES LIVESTOCK SANITARY ASSOCIATION

BY DR. J. W. CONNAWAY, D.V.M.

Presented by A. J. DURANT, B.S., A.M., & D.V.M.

Columbia, Missouri

Today at the 50th anniversary of the United States Live Stock Sanitary Association, I am proud to be the one selected to present to this organization a few notes on the early history of the organization of the United States Live Stock Sanitary Association, as given to me by Dr. John W. Connaway. I am proud to be the one to present this for two reasons. One is that I am a member of this great organization, and have served in various capacities, particularly with reference to poultry pathology, over a period of many years. Second, I am proud to present this paper because of my personal association with the author of the main part of this paper—a great scientist, and a fearless advocate of sane and sound methods for the eradication of infectious diseases from these United States. After almost thirty years of close association with Dr. Connaway, I can say with conviction that to properly eulogize this man is beyond my powers. Dr. Connaway was 87 years old November 18, 1946. His mind today is quite as clear as in the old days when he stood before this organization and fearlessly expounded sound principles of disease prevention and eradication.

I could tell you many interesting anecdotes regarding Dr. Connaway during the many pleasant years of my association with him, but time permits of a few only. I recall one incident which illustrates his care in diction. I was making some notes for him on some research which we were doing in the study of Brucellosis of cattle, and I asked him what the abbreviation for Louisiana was and he said, "Do not use the abbreviation, spell the word." After I spelled Louisiana he looked over my shoulder and remarked, "I see now why you wanted the abbreviation."

Another incident was of his absentmindedness. I came to the veterinary building at one time during a holiday to check on some experimental work I was doing, and Dr. Connaway came into the office. Two and a half hours later I stepped out of the building and there was his old Overland car still idling and there was still some gas left. I saw him one day tap one of his colleagues on the shoulder, who was winding his watch during a general faculty meeting. He said, "Stop winding your watch, Calvert, I can't hear what the president is saying."

I also recall another incident. Dr. Connaway and I had been on a trip to Sedalia, Missouri to investigate sterility in some very fine Berkshire hogs. Because of Dr. Connaway's benign and kindly face, a man on the train approached him and inquired: "Are you a minister of the gospel?" Dr. Connaway looked at him for a moment and said, "No, I am a double-barrel doctor." He is truly a double-barrel doctor—having a degree in human medicine as well as a veterinary degree.

I quote you almost verbatim from an interview which I had with Dr. Connaway
just a few weeks ago in regard to the first organization meeting of this organization we now call, the United States Live Stock Sanitary Association.

The United States Live Stock Sanitary Association emerged from a research background dealing primarily with Texas fever in which the State Colleges of Agriculture of Missouri and Texas entered upon a cooperative research project to discover the cause of the malady and to develop measures for its eradication. This Texas fever project was the first on record of cooperation between states on any project of mutual interest—Missouri's interest at the time being the menace of an unknown "summer time" infection carried by the "long horn" bovines from the South; the interest of the Texas cattle raisers—such as Robert Kleberg, Manager of the King Ranch, was an open all year round market in the north which the quarantine line cut off until the "frost was on the punkin' and the fodder was in the shock".

The record of these first researches initiated by my predecessor, Dr. Paul Paquin, a student of Louis Pasteur, is published in the Missouri Experiment Station records. I was a participant in the early stages of these experiments assigned to testing the infectiousness of food stuffs from presumably infected premises in the south and materials sent by Dr. Mark Francis of the Texas Experiment Station—feces, urine, bile, saliva, and blood fed in lavish quantity—even pulp of macerated mature-stage ticks, proved innocuous.

The immediate stimulus for the organization of this association was the publication of Missouri Bulletin 37 in January 1897, on the subject of Texas fever. The Missouri Bulletin 37 confirmed the tick theory, which was first promulgated by southern cattle raisers—primarily Robert J. Kleburg of the King Ranch, father of ex-Congressman Kleburg, and proven by the brilliant work of Doctors Theobald Smith, F. S. Kilbourne, and Cooper Curtice.

Those having a pioneer part in laying the foundation that resulted in the establishment of the United States Live Stock Sanitary Association were Doctors Theobald Smith, F. S. Kilbourne, Cooper Curtice of the Bureau of Animal Industry, Dr. J. W. Connaway, Paul Evans of the Missouri Station, Mark Francis of the Texas Station, C. A. Cary of the Alabama Station, and Nelson Mayo of the Kansas Station.

The important incidents that led to the calling of the meeting at Fort Worth, Texas which resulted in the formation of this association were outbreaks of Texas fever in Illinois, southern Missouri, and Kansas. The secretaries of the Live Stock Boards of these states were greatly concerned as to the spread of Texas fever and in correspondence concluded to hold a meeting at some undesignated place in one of these states. Word of this got into the papers and the Fort Worth management of the Fort Worth stock yards, learning of it, sent an invitation to hold the meeting at Fort Worth, where these yards had build a dipping vat, with the purpose of freeing cattle of the ticks for shipment north of the quarantine line for grazing purposes. The purpose of this meeting, which was held Sept. 28–29, 1897, and which really was the initial meeting of the United States Live Stock organization, was to urge the Federal government to greater activity in the protection of the quarantine line. The purpose of the stock yards in maintaining a dipping vat was to create greater interest in the dipping of cattle for the commercial shipment of southern
cattle into northern territory. I do not know how many states north and south of the quarantine line received invitations to attend this meeting but very little interest was manifested. The Bureau had on the grounds one of its experimental experts testing out dips—Dr. Victor Norgaard, and a few of the field inspectors. Those who attended the meeting at Fort Worth were one of the members of the Missouri Board of Agriculture, Col. John R. Rippey and I; no representative from Kansas; from Ohio, Dr. C. P. Johnson, Chairman of the Live Stock Sanitary Board of that state; the state veterinarian from Illinois, Dr. Lovejoy, a layman; and Dr. Gresswell, State Veterinarian of Colorado, a kinsman of the English veterinary author who had interests in ranching in Colorado, and who at this particular time was wanting to pronounce the dipping a success and to open up the line for entry of cattle into Colorado before Dr. Norgaard was yet willing to admit dipping a success. The Omaha stock yards had a representative, whose name I do not recall, who was also very anxious to pronounce the dipping a success before either Dr. Norgaard or I felt it was safe to open the gates for the admission of dipped cattle in a wholesale manner. I recall that I had considerable difficulty as a member of the committee upon its report of the success of the dipping, to prevent the premature acceptance and use. We, the committee, finally pronounced it very promising. This committee report was made at the meeting at Fort Worth. The full report was printed in the annual report of the Illinois Live Stock Sanitary Board of that same year, along with extracts of the Missouri Bulletin 37, which was the inspiration of the calling for the meeting. This represents the first meeting of the United States Live Stock Sanitary Association. At the close of the conference someone—I think Mr. C. P. Johnson, who presided as Chairman—made a motion that they constitute a permanent organization to meet annually to discuss these interstate problems in cooperation with the Federal Bureau. It was accepted and passed. The prime credit I ascribe to the interest of four states—Illinois, Kansas, Texas, and Missouri—and if I may be permitted to be a bit egotistical I will say that Bulletin 37's confirmation of the tick theory was the spark plug that set cattle dipping for the eradication of the fever tick into operation. That entire bulletin was reprinted by the Illinois Live Stock Sanitary Association in the first report of this United States Live Stock Sanitary Association.

I wish to add that in spite of the brilliant research work of Doctors Theobald Smith, Kilbourne, and Cooper Curtice, there were few live stock sanitary boards, stockmen, or veterinarians who took any stock in the validity of the tick as the carrier of the infection. My own state veterinarian, Dr. White, thought there was nothing more absurd. Dr. H. J. Dettmers, the founder of the veterinary school at the Ohio State University, in a letter to me, said, there was nothing more preposterous; and I may say that Dr. Francis, his first graduate, put me up to writing his old preceptor asking what he thought about the tick theory—and that was his reply after his own first graduate and I had carried out crucial experiments to remove all possible doubt as to the truth of the proposition; and our work seemed to be necessary because of the doubt that existed very generally among veterinarians and livestock men. For instance, Dr. Dettmers said Doctors Smith, Kilbourne and Curtice had not removed all possibility of other sources of infection than the tick. The work which Dr. Francis and I did was done on grounds where no infection
from infected southern cattle had been and through ticks sent to the Missouri
Station through the mails repeated work in its practical details as carried out by
Dr. Cooper Curtice. This confirmatory work of Dr. Francis and I was essential
to meet the objections that had been raised. For instance, at the second meeting
held in St. Louis during the fall of that same year, at which the representatives of
other live stock sanitary boards attended, and among them Vincenheller, Chairman
of the Arkansas Live Stock Sanitary Board, who expressed emphatically his dis-
belief that the tick had anything to do with the spread of Texas fever. He said,
“Nuts to that damn fool notion that ticks from healthy cattle from any part of
Arkansas are a menace to cattle of any state.” He said, “those swivel chair
guys in Washington ought to get wise to bloody murrain in cattle and how to treat
it.” I sent him the Missouri Experiment Station Bulletin No. 37’s confirmation
of the tick theory of transmission of Texas fever, Cooperative experiments of Dr.
John W. Connaway of the Missouri College of Agriculture and Experiment Station,
and Dr. Mark Francis, the head of similar work at College Station—Bryan Station,
Texas.

I wish to add that diseases other than Texas fever, and particularly tuberculosis,
were discussed at the first and second meetings. In fact, the Illinois Board was
engaged vigorously in combatting tuberculosis at that time, as was Missouri and
several other states. As I have stated before, the main purpose of the two meetings
was to fix the dates of opening and closing the quarantine line for Texas fever;
that is, “when the frost is on the punkin’ and the fodder’s in the shock”, which
brings to my memory the first Longhorns that I saw and fed on my father’s farm
in south Missouri, long before we knew the tick had anything to do with the trans-
mission of Texas fever. I, of course, remember many, many meetings of this asso-
ciation. I was president of this association in 1931 and have watched its growth
from its origin in the control of Texas fever, and the magnificent work done by a
great host of diligent tick hounds that have chased the ticks from a line extending
from the Atlantic ocean up in middle Virginia across the continent to the Pacific
Ocean above San Francisco. Near the western end of the line I vaccinated more
than 1000 head of calves for prevention of Texas fever, which is now a useless process
in the control of the disease in the United States of America.
MEMORIAL SERVICE

December 4, 1946

By J. L. Axby, D.V.M.

Indianapolis, Indiana

Mr. President, Members of the Association, Ladies, and Gentlemen: The following list of names represents the members who have died during the past year, and it is out of respect to them—for what they did and for what they were—that we conduct this service.

W. T. Miller (KSC '24), 49, Indianapolis, Ind., died July 1, 1946. He was born in Pittsburgh, Pa., Oct. 26, 1896. He received his D.V.M. degree from Kansas State College in 1924, his M.S. and PhD. degrees from Cornell University, in 1929 and 1930. Until 1943, he was with the U. S. B. A. I. in bovine mastitis and other animal disease research work. For the past two years, he had been in charge of the Pitman-Moore anaerobic bacterin and toxin departments. Dr. Miller was admitted to the AVMA in 1929.

D. D. Bradbury (TH '15), 57, Fairbanks, Ind., died April 24, 1946. He was born at York, Ill., Sept. 15, 1888. Dr. Bradbury was admitted to the AVMA in 1920.

Their names having been read to you, may I respectfully request all present to arise and remain standing for a few moments in silent prayer for the peaceful repose of their souls.

(Silent prayer.)

I would like to visualize the persons we to-day memorialize as coming into the world entirely dependent upon maternal and paternal watchfulness and care. Gradually as the years passed, they learned to become more and more independent and self reliant. At the customary age of six years they entered the elementary school, the completion of which was followed by a course of study in a commissioned high school which prepared them for entrance into a recognized college. At the completion of this training for life on earth they became members of a graduating class for which a commencement was conducted, and to each graduate there was given a diploma, stating that he had met the requirements and was qualified to commence an active life in a complex society and from thence prove that life is too short to be selfish, ignoble, or little.

Thus, my friends, they graduated and on their own commenced a human life on earth, definitely limited by years of time, during which years they experienced worry, pain, sorrow, and doubt. Some were beset with worry only, others with pain, heartbreak, or doubt, and some with all combined. But out of these trials and tribulations came a determination to devote their lives to worth-while actions and conduct, to lend a hand wherever needed, to lift up the underprivileged, to look up, to help—always proclaiming great forward-looking thoughts, ever displaying real kindliness and affection, and striving for the completion of undertakings of benefit to many and of long endurance.

15
Thus they completed what they commenced on graduation day. But "The soul is not dead that slumbers", it is only away preparing for another commencement into Life Eternal on that beautiful isle of somewhere, in a land not made with hands, eternal in the heavens. We have the promise, "If it were not so, I would have told you."

So we view their passing as the entrance into Life Eternal. Their virtues revealed on earth we shall emulate, their memory we shall revere, and for their souls our prayers shall be for heavenly peace.
EXPERIENCES IN THE CONTROL OF RABIES IN NEW YORK STATE

BY A. ZEISSIG, D.V.M., AND ROBERT F. KORNS, M.D.

Veterinary Consultant and Associate Director, Division of Communicable Diseases, New York State Department of Health, Albany, New York

THE PROBLEM

Rabies has occurred for many years in New York State. The reported annual incidence of the disease in the state, exclusive of New York City, since 1932, as presented in Table I, gives some idea of the increasing importance of the problem. During the major portion of this period the disease was confined to the Lower Hudson Valley. However, in 1943 it first appeared in the southwestern corner of the State and in the following year another new focus developed in Broome County, on the southern border, near the center of the State. This was coincidental with the disappearance of the disease from the Hudson Valley area and has brought with it striking changes in the types of animals affected. The problem was sufficiently alarming, particularly the discovery of fifteen rabid foxes in Chautauqua County in 1944, to call for the creation of an interdepartmental conference of representatives of the State Departments of Agriculture and Markets, Conservation, and Health. This group felt that the fox problem would undoubtedly solve itself and that emphasis should be placed on dog control activities. As predicted, fox rabies did disappear from this western focus. However, it later appeared in the Central New York focus where it has subsequently assumed a dominant role.

Figure 1 illustrates the geographic distribution of reported cases of rabies in dogs during 1946, through December 19. It will be noted that the three foci of the disease are clearly separated: the western and central foci, already mentioned, and an eastern focus of recent origin. Figures 2 and 3 indicate the distribution of fox and cattle rabies during this same period. The discovered rabid foxes have been confined entirely to the central focus and, for the most part, the rabid cattle have also been confined to this area.

Figure 4 presents the details of the monthly incidence of rabies in various species of animals in Upstate New York during the period 1943 to date. This illustrates the striking swing in seasonal distribution, in part natural and in the case of dogs partly attributable to vaccination, a factor which will be discussed later. It should be made clear that all animals included in the figures presented were proven by laboratory examination to have had rabies.

In all areas human beings have been attacked by rabid animals, resulting in the death of one person in 1944 and another in 1945. These represent the only cases of human rabies reported in the upstate area since 1930. These deaths, however, give only a partial measure of the damage, both mental and physical, caused to human beings in connection with the attack of a rabid animal. During 1945, for example, 243 persons bitten by known rabid animals were treated with rabies vaccine. None of these persons developed rabies. The single human case occurred
Fig. 1. Rabies in dogs. New York State, exclusive of New York City, 1946 (through Dec. 19).
Fig. 3. Rabies in cattle. New York State, exclusive of New York City, 1946 (through Dec. 19).
Fig. 4. Reported rabies. Upstate New York, by month, and by species of animal, 1943–1946.
among fourteen persons known to have been bitten by rabid animals but not receiving treatment. Based on information available, during that year at least a thousand persons received post-bite antirabies vaccine, a prophylactic procedure that is not without danger.

CONTROL MEASURES

Prior to 1945 efforts to control rabies in Upstate New York were directed toward the dog only. The method employed was essentially merely the restriction of the activities of dogs in areas where rabies was certified to exist by the State Commissioner of Health. The usual procedure was to certify a township at a time as rabies appeared. In these areas, according to law, dogs were not allowed to run at large except on the property of the owner or on that of another person with his knowledge and consent. Muzzles as control tools had been previously discarded because of the difficulty of properly applying them and because they were so frequently applied to the wrong dog.

In 1945 the New York State Public Health Law was amended to allow properly vaccinated dogs the privilege of being at large in certified areas. It was hoped that this privilege would stimulate owners to have their dogs immunized against rabies on a voluntary basis. It soon became apparent, however, that in spite of the liberalization of the Public Health Law, the disease continued to spread. It seemed necessary, therefore, for the State Department of Health to take active part in assisting local communities in the organization of rabies control programs, employing both dog control and mass vaccination methods. The position of Veterinary Consultant in Rabies Control was therefore created for this purpose.

An opportunity to evaluate such a program presented itself in the case of Tomp-
CONTROL OF RABIES IN NEW YORK STATE

kins County in June 1945 (1). The program conducted by that county appeared to be so successful that others patterned upon it have been instituted in seventeen counties since that time. In two of these counties a vaccination program has been provided for a second year. The experiences recorded below represent those encountered in the course of persuading these seventeen counties to embark on control programs. An attempt has been made to evaluate their effectiveness, even though at the present time it is too early to offer a final interpretation.

FOX AND CATTLE RABIES

As mentioned above, fox rabies is important in the central area of infection. We know, however, that only a small fraction of the cases of rabies which occur in the fox ever become a matter of record. Actually, our reports include only those animals, crazed by the disease, which come to habitations or attack persons or farm animals, are killed, and sent to approved laboratories for confirmation of the diagnosis. Furthermore, when the occurrence of rabies in foxes becomes commonplace in an area, it is common practice to simply kill the animals and discard their carcasses.

The geographic distribution of rabies in cattle has coincided almost exactly with that in foxes. This fact plus the parallel rise in incidence of the disease in these two species with almost complete absence of the disease in dogs certainly lends weight to the conclusion that the disease in one is derived from the other, even though very few foxes have been observed actually to bite cattle. The danger to humans occasioned by rabid foxes and the significant financial loss to farmers because of rabies in cattle have made it mandatory that some sort of control be attempted. In addition, of course, the eradication of the disease in these animals is a necessary corollary or even prerequisite to the eradication in dogs.

Admittedly, controlling fox rabies is difficult. In areas where it has been present for some time it appears to have reduced the fox population to an extremely low level. Where the disease is active, however, the loss in farm animals is high and people in the rural areas hesitate to go out of doors. During the hunting season just past, we have heard of numerous incidents in which hunters and their dogs have been attacked by so-called "crazy foxes." The disease in the fox appears to spread slowly, since the extensive journeys of the dog with the furious form of rabies apparently are not made by the fox. Figure 5 illustrates the manner and the rate of spread of rabies in foxes according to our records. It will be noted that the disease first appeared in six townships, five of which lie in northern Broome and southern Chenango counties. During the second six-month period, it had extended to twelve nearby townships.

In the first six months of 1946, the disease had made its appearance in thirty-four additional townships, and since July it has appeared in seventeen new townships. This represents a virtually uncontrolled epizootic which has spread radially, like a grass fire, from the point at which it appears to have started in Broome County. Similar radial spread has been noted in epidemics of poliomyelitis and measles. This has been interpreted to mean person-to-person spread of the disease. Certainly there can be little doubt of the fox-to-fox transmission in this epizootic.

An attempt to prevent further progress of the disease in the fox has just been
FIG. 5. Spread of fox and cattle rabies by towns. Upstate New York, 1945-46. Towns reporting rabies in foxes or cows for the first time.
begun under the direction of the New York State Conservation Department. This plan is based first on the relatively slow spread of the disease in the fox possibly due to the fact that he does not travel very far when he is in the symptomatic stage of the disease, and second on the fact that the fox usually remains in a localized territory which he claims as his own. This holds true for almost the entire year and includes the denning and rearing seasons. During the fall there may be a fairly extensive migration of young foxes when, after rearing, the families are broken up. Each fox then takes up his own territorial claim. It would thus seem to be possible to rid an area of foxes by systematic trapping operations maintained through the year. The Conservation Department has now established a line of traps surrounding the area in which fox rabies is known to occur, manned by professional trappers of proven ability. Our hope is that this zone of scarcity or band of depleted fox population will act in the same manner in preventing the spread of rabies among foxes as does a fire lane cut through a forest in advance of an approaching forest fire. This scheme has not been in operation long enough for us to be in a position to evaluate its effectiveness. We do not expect it to be perfect, but hope that it will divide the disease into pockets which can then be attacked by individual trappers or groups of trappers.

The control of the disease in cattle in this area would seem to be largely dependent on its control in foxes. Practical experience with the vaccination of cattle against rabies in New York State has been inadequate to indicate its effectiveness.

**DOG RABIES**

Our plan for the control of rabies in the dog is predicated upon the nature of the disease in this species. It also takes into consideration the human relationships which are involved. Most of the spread of canine rabies is done by what we call ‘fifth columnists.’ These are dogs not known to have been infected who develop the disease while loose, or are dogs known to have been bitten but not properly confined at the time symptoms develop. If one of these dogs travels into an area in which the disease is not present at the time, his itinerary is usually clearly defined by the cases of rabies which develop along it. A number of examples of such flights by dogs with the furious type of rabies are shown in Figure 6. It will be seen that they travel at least the length or breadth of the average New York State country. We believe that this is the most important means of dissemination of canine rabies and therefore a chief point of attack.

There is another type of canine disseminator of rabies which we call the “paratrooper.” This is an animal which becomes infected in one area and is then transported during the incubation period, almost invariably in the automobile of the family by whom he is owned, to another rabies free area. Occasionally rabid dogs are imported in this manner from out of State, as in one recent instance from Florida. The “paratrooper” also represents a problem, though less important, which would be both difficult and expensive to control. To prevent the introduction of infection in this manner via common carriers would be relatively simple; however, the control of the dogs transported by automobile would involve the patrolling and setting up of road blocks on all roads leading into the State. We have, therefore, not established any regulations with respect to the importation
of dogs into New York State because we feel that they could not be enforced. In view of the extended distances occasionally traveled by rabid dogs, it seems essential that the smallest geographic unit to organize a control program be the county. There are, of course, other reasons why the county is a more effective control unit than a smaller political subdivision.

Without a doubt, the most effective way to prevent the spread of and eventually eliminate rabies in dogs is through control of their activities. Such methods aim at the direct interruption of the cycle of transmission. One of the places at which this cycle can be interrupted is in the proper handling of the dog showing symptoms suspicious of rabies. This requires that the owner have a sufficient knowledge of the disease to recognize the nature of the abnormal behavior of the animal. If he is also sufficiently convinced of his public duty in the matter, he will see that such an animal is properly confined until the cause of its abnormal behavior is established.

A second method of interrupting the cycle of transmission is through the proper handling of the dog known to have been bitten by a rabid animal. This is the most difficult of dog control methods to put into practice. The stumbling blocks are the inconvenience and expense caused the owner if the dog is held for observation. The general lack of suitable isolation facilities and the reluctance of many dog owners to destroy exposed animals for the sake of removing all possibility that further harm will be done if he has become infected also complicate the problem. In our experience this is the weakest phase of the dog control program.

We no longer require the muzzling of dogs to prevent the transmission of this disease because it is difficult to carry out in the first place. Secondly, the muzzle invariably is on the dog whose owner is conscientious and, by the same token, will take good care of him otherwise. The wandering type of dog is not well looked after by his owner; hence, is not muzzled and is more apt to be a disseminator of this disease. We do require that dogs be under control in an area certified by the Commissioner as one in which rabies exists. By this we mean that the dog be restrained by a leash when on public property. He may be taken anywhere his owner wishes in an automobile. This is not considered to be at large. He may be on the property of his owner or on that of some other person with that person’s knowledge and assent. Hence, in rural areas, dogs, for all practical purposes, are always at large.

Most dog owners confronted with official rules and regulations restricting the liberty of their dogs assume a defensive attitude. They infer that it is implied that their pets are a source of danger to others. This they resent. We have attempted to overcome this difficulty in securing the dog owners cooperation by the following approach. In an area certified as one in which rabies exists, the dog is faced with a danger which he cannot be expected to realize. Neither can he be expected to defend himself against it. It, therefore, becomes the moral obligation of the owner to protect his dog as he would a child. Giving the dog owner a job to do, instead of telling him what he cannot do, seems to us to be more fruitful of results.

**VACCINATION**

The vaccination of dogs against rabies, particularly since the advent of the Habel test, has become more and more firmly established as a valuable adjunct to
dog control in interrupting the cycle of infection. We believe that it must be used in such a manner as to take into account its possibilities and limitations. The rabies vaccines now available produce an immunity which is relative and transient. The peak of antibody response to a single injection or to the last of a series is reached approximately one month afterward. The resistance of the vaccinated individual then falls gradually from that time on. In some individuals there seems to be sufficient resistance at the end of a year, or perhaps longer, to withstand reasonable exposure. In other individuals, however, resistance has fallen to a very low level by the end of a year. Doubtless, there are some individuals who do not respond at all to the injection of the vaccine.

In view of these basic facts, it would be a mistake to sell this procedure as being infallible. We have knowledge of failures of vaccination to protect, which though they are not numerous, nevertheless require that the public be prepared to accept some of them as inevitable. In our use of this procedure, the objective has been

---

**To the Dog Owner Addressed:**

You are requested to bring your dog or dogs to a FREE CLINIC at..........

.................................

between 7 and 9 p.m., on..................

Dogs must be present by 8:30 p.m. in order to be sure that they will be vaccinated before the clinic closes. *Each dog must be on a leash and accompanied by a person capable of controlling same.*

**THE LIVINGSTON COUNTY RABIES ADVISORY COUNCIL**

**BRING THIS CARD WITH YOU**

---

**Fig. 7**

to place the entire dog population in a phase of increased resistance in the shortest possible space of time. Thus, the peak of immunity is reached simultaneously by all dogs, allowing for a break in the chain of transmission. To accomplish this purpose, we have suggested to counties that they offer free clinics at which large numbers of dogs can be vaccinated by the veterinarians practicing in that community. Clinics are offered in each township in a county. The number is governed by the geography of the region and the size of its dog population. Each known dog owner is sent a post card, as illustrated in Figure 7, making a definite appointment. In our experience, as many as one hundred dogs can be vaccinated at a clinic of two hours duration with only one veterinarian in attendance. Two clerks are needed to make out vaccination certificates and check off the dogs on the enumerator's lists. We do not question the dog owner about licensing since if such an issue were raised, attendance at clinics might be lessened. It is essential to arrange the clinic in a place through which the dogs can move without having to pass by one another, thus avoiding confusion. Such conditions are provided by central school garages, community halls, fire houses, etc. These clinics should be concentrated in the
shortest possible space of time to establish a significantly high barrier of immunity in the dog population, and to capitalize on the public interest created by the occurrence of rabies in the area and the intense educational program conducted in preparation for the clinics. It should be noted that this vaccination program is entirely voluntary, there being no element of compulsion in it.

**BUFFER ZONE**

It is not particularly difficult to convince a community in which there have been large numbers of cases of rabies in animals, with resultant increased exposures of human beings to such animals, of the necessity of concerted action to eliminate the danger. If the activities of those responsible for rabies control are confined to such areas, however, little progress in eradication will be made since the wave of rabies spread will travel faster than the control program can be organized. We have, therefore, concentrated our activities on areas outside the known infected ones, with the idea of creating buffer zones in which dog control and prophylactic immunization are practiced. In this manner, we have hoped to prevent further spread. It would appear that this plan of attack has been fairly successful as far as canine rabies is concerned. The three Upstate New York foci, mentioned above, have not become confluent. Furthermore, within recent months the few cases of canine rabies which have occurred have almost all been in what might be regarded as the focal points of infection, namely, Erie, Broome, and Nassau Counties.

It is sometimes difficult to sell a county the idea of spending money for dog vaccination, of wishing on itself the inconvenience of dog control, and of expending energy in getting these two procedures put into practice, all before rabies appears in the area. In our experience, however, such efforts bear the most fruit. Furthermore, counties which have been convinced of the desirability of this procedure have been well pleased with the outcome. For example, Delaware County, which vaccinated its dogs in March and April of this year, has yet to report a case of rabies in the dog, although it has had rabid foxes since January, and has lost an increasingly large number of cattle from this disease since mid-summer.

**EDUCATIONAL PROGRAM**

In order to initiate control measures in either an area where the disease has become a serious problem or an area which is a part of the buffer zone mentioned above, it is necessary to educate the public about the disease. If they understand what the disease is like and how it is transmitted, the steps necessary for its control are obvious. When the public has been so educated, it will comply with the suggested control measures willingly. There are always a few individuals who will not cooperate unless compelled to do so. Suitable measures can be taken in these cases. In an adequately educated community, they are not very numerous.

There are always some doubts and fears in the minds of the dog owning public about the vaccination procedure in particular. We have not encountered many serious difficulties in this respect, although a variety of minor complaints have come to our attention; e.g., that vaccination kills a great many dogs; it ruins the noses of hunting dogs; the State is going to come in and shoot a lot of dogs; the pro-
procedure of vaccination would be compulsory and would cost every dog owner a sizable sum of money; and the whole scheme was a veterinary racket and an excuse for making jobs for bureaucrats.

Our approach to this situation has been to meet with the groups and individuals from whom these rumors had originated. We have talked with them personally and found them usually to be well-meaning individuals who had simply been badly informed. We have met with all sorts of groups in the area who would listen to us and explained what we were proposing. It is our feeling that much of the antagonism has disappeared. One of the counties in which this problem was encountered has just embarked on a county-sponsored program. We are convinced that even in areas where such resistance is not met, it is absolutely essential to educate the public about the disease, and the possibilities as well as limitations of control measures, if intelligent cooperation is to be obtained. If the maximum good is to be accomplished, it is necessary that the control of rabies be made a community project. No particular individual or group should be in the spotlight nor take any individual credit for the results which are accomplished. All should do their share toward accomplishing the goal set. We have found that the setting up of what we call a Rabies Advisory Council for the county satisfies this requirement. It may be modified to suit the needs of any area. It is suggested, however, that this group consist of the following:

1. A local health officer
2. A veterinarian
3. The agency responsible for dog control (in New York State this would be either the S.P.C.A. or county and town dog wardens)
4. City police chiefs
5. County sheriff
6. Dog owners (we suggest at least two, or more if desired)
7. A representative of farm organizations
8. A representative of the Board of Supervisors, which in New York State is the governing body of the county

Such a council should have a chairman. He can be elected by the council. He may be a health officer. We believe that the chairman's energy, enthusiasm, and his ability to organize the people have had more influence on the results than his label.

Admittedly, such a council is less desirable from the administrative standpoint than a single individual would be. However, having had the opportunity to observe a number of them in action, we are convinced that in spite of the slowing up of procedure, such councils can accomplish things which any individual could not. For example, if the enforcement of dog control leaves something to be desired, the council can take up the matter with the person or group which is negligent. Criticism of this sort by the council seems to be taken more gracefully, and the chances are greater that something will be done about it than would be the case if it came from a single individual. We have also found such councils to be the source of new ideas or new approaches to putting control measures into practice.
A control program, essentially as outlined above, was put into practice in Tompkins County in June, 1945. As a result of the program, rabies apparently was eliminated for the time being at least. After the program, which included the vaccination of over seventy per cent of the dogs at county expense, was completed, the Rabies Advisory Council met and discussed what had been done. One of the points raised was that in snuffing out this disease, Tompkins County had not only served its selfish interests, but had also protected adjoining counties to which the disease might otherwise have spread. On this basis, it was felt that part of the financial cost of the program should be borne by the State. The county authorities, therefore, requested State aid. After some delay State financial aid was made available to counties on the basis of fifty per cent of the actual cost of the program, with a ceiling of thirty-five cents per vaccinated dog as the State's share. There is no doubt that our ability to offer such financial assistance has had much to do with the willingness of sixteen counties to organize control programs since it became available.

THE RESULTS

The plan for the control of rabies outlined above has been advocated for all the counties in New York State in which the disease exists. Furthermore, as indicated above, we have tried with variable success to convince counties threatened with this disease to organize in advance of its appearance.

There are several ways in which the effectiveness of this program can be measured. One of the simplest is to tabulate the cases of rabies which have occurred in dogs before and after the initiation of a control program. Such a tabulation has been made for the fifteen New York State counties in which some sort of organized countywide control program has been completed. The findings are portrayed graphically in Figure 8. The area on the left-hand side of the chart represents the composite of the number of cases of canine rabies which occurred in these fifteen counties prior to the inauguration of a control program in each county. The months preceding the program are indicated below the bar diagram along with the number of counties represented in any given month. A similar presentation of cases of rabies occurring in the months following the inauguration of a control program is indicated in the right-hand part of the diagram. The marked reduction in the frequency with which cases of the disease occur in dogs is clearly apparent. This reduction occurred despite the concomitant rise in fox and cattle rabies in most of this area. It should be made clear, however, that this type of analysis does not clearly indicate to what extent dog control may have influenced the reported incidence of canine rabies, nor does it eliminate the possibility that the decline may represent merely a seasonal swing in the incidence as noted in Figure 4.

The central focus, previously referred to, would seem to offer the most ideal circumstances for the evaluation of the efficacy of canine vaccination since vaccination programs have been carried out in each county, and as illustrated in Figure 9, canine rabies has continued to exist since it was first discovered in the fall of
Fig. 8. Total cases of canine rabies before and after initiation of a control program in 15 New York State counties.
1944. However, the incidence has decreased and actually in 1946 over half of the cases of canine rabies have been confined to one county in which the control program suggested was not carried out in all its details. At the bottom of Figure 9 the solid line opposite the name of the county indicates the duration of the outbreak of the disease in that county. The broken line immediately above it indicates the period during which the mass vaccination of dogs was carried out.
The percentage following this broken line indicates the proportion of the enumerated dogs in that county which were vaccinated during the period cited. All of these areas except the last county, Madison, have been designated as areas where vaccinated dogs may be allowed to run at large. For all practical purposes, this means that all dogs run at large since at present we lack an easy means of differentiating between the two classes of dogs.

In this same area, as will be noted in the second bar diagram of the figure, fox rabies has increased. We know that the disease in foxes is grossly underreported. Thus, the dogs of this area, particularly rural dogs, have had the opportunity of being exposed to rabies.

The third bar diagram in the chart indicates the frequency with which this disease has occurred in cattle. Attention is called particularly to what has happened in 1946. After the cattle in this area were turned out to pasture in the spring, cases of rabies appeared in them with increasing frequency up to the time that this is being written. There is not much doubt that most, if not all, of these animals contracted the disease through exposure to the large number of rabid foxes with which they came in contact while at pasture. Thus, the cattle population serves as an indicator of the presence of rabies infection in the area. We feel that the immunity of the vaccinated dogs in this area has been effectively challenged by rabid foxes.

Another index of the effectiveness of mass vaccination of dogs is furnished by a study of the rabies attack rate in the vaccinated versus the non-vaccinated dog populations. Vaccination failures are defined as those cases of rabies which occur in dogs one to eighteen months after vaccination. Considering the total of thirteen counties for which detailed information concerning the number of dogs vaccinated is available, a total of nine failures were observed during the course of 452,130 dog-months of exposure to rabies by vaccinated dogs, or a rate of 2.0 per 100,000 dog-months. This compares to 110 cases in 618,169 dog-months of exposure in non-vaccinated dogs, or a rate of 17.8 per 100,000 dog-months. Utilizing only licensed dogs for this analysis does not alter the results significantly. Thus the likelihood that this nine-fold difference in attack rate is due to the presence of a disproportionate number of stray dogs among the non-vaccinated group does not seem likely. These findings are in keeping with those reported for the Birmingham, Alabama, experience (2) where the rabies attack rate among non-immunized dogs was eight times that in immunized dogs observed in the same area during the same time period. Considering the central focus alone, since as indicated above it probably represents a more ideal experiment, a total of two failures have been observed among 324,080 dog-months exposure in vaccinated dogs, or a ratio of 0.6 per 100,000. This compares to 76 cases of rabies in 304,328 dog-months of exposure in non-vaccinated dogs, or a rate of 24.9 per 100,000, forty-one times greater. It is to be realized that any error in these estimates would be such as to minimize the effectiveness of vaccination, since we do not have information on the fairly large number of dogs which have been vaccinated privately. These figures are subject to revision when more complete data are available; however, their general trend is clearly evident.

The findings for the central focus with respect to the occurrence of rabies in
CONTROL OF RABIES IN NEW YORK STATE 35

vaccinated and non-vaccinated dog populations are presented graphically in Figure 10. The lower portion of the chart illustrates the total dog population included in the study area during any given month. After completion of the vaccination program in any given county, the dog population was added, non-immunized dogs being indicated in black and immunized by cross-hatching. The upper portion of the chart presents the discovered cases of canine rabies in the area included for each month distinguished as to the immunity status of the dog. The striking con-

![Graph showing rabies cases in vaccinated and non-vaccinated dogs.]

centration of rabies in the relatively small non-immunized dog population is apparent. Had similar rates existed in the immunized population, 82 rabid dogs instead of only two should have been discovered in this immunized group. The two failures noted, one in February and one in November, 1946, occurred in dogs vaccinated six and eight months, respectively, prior to onset of rabies.

**SUMMARY**

1. The problem of rabies in New York State has been presented, showing the marked change in its composition during 1946 when cases were reported in 377 dogs, 308 foxes, 440 cattle, and 48 animals of other species.
2. Evidence has been presented indicating the value of prophylactic canine antirabies vaccination. The experience of thirteen counties where county wide vaccination programs have been carried out demonstrates the occurrence of nine times as much rabies in non-vaccinated as in vaccinated dogs. In a more rigidly controlled area comprising seven counties the attack rate in non-vaccinated dogs was forty-one times as great as that in vaccinated dogs.

3. Based on experience gained in sponsoring county control programs, the following general recommendations have been presented:
   a. It is felt that mass dog vaccination is a valuable adjunct to dog control though it is essential that both technics be used.
   b. It is suggested that these measures preferably be applied over an area which is at least county wide.
   c. Such control measures should be put into effect in advance of the introduction of the disease, when cases are occurring in adjacent counties.
   d. The importance of an educational program to implement application of control measures should be emphasized.
   e. A well-qualified person employed on the State level to promote and supervise the control program is essential.
   f. State financial aid to counties for the conducting of dog vaccination clinics has been of great help in New York State.
   g. The placing of local authority in the hands of a county rabies advisory committee made up of representatives of all groups concerned with the problem is deemed wise.
   h. Emphasis should be placed on the benefits to be derived by the individual dog and his owner from the program, rather than on the legal necessity of complying with the regulations or laws that may apply.

BIBLIOGRAPHY

CONTINUED STUDIES IN RABIES CONTROL IN MARYLAND

BY A. L. BRUECKNER, V.M.D.

Director, Live Stock Sanitary Service, College Park, Maryland

Rabies has been controlled in Maryland to the extent of virtual eradication during the period from June, 1944 to the present.

In previous reports it was pointed out that the disease had been present from 1931 to 1942 in small numbers of cases; that in 1943 an outbreak (108 cases) occurred, principally in the two counties adjacent to the District of Columbia; that in 1944 the outbreak (239 cases) continued in Prince George's and Montgomery Counties and cases appeared also in eight other counties and in Baltimore City; and that in 1945 the evidence of the disease (68 cases) was markedly reduced. Vaccination as an experimental procedure was added to the usual quarantine restrictions in Prince George's and Montgomery Counties in 1944 and 1945. In the latter county the disease was virtually eradicated and only three cases have been diagnosed there since May, 1944, the last one in February, 1945. In Prince George's where quarantine restrictions were not well observed, the number of cases dropped following the 1944 vaccination program, but increased again before a year had passed. Repetition of the vaccination program in 1945 produced a rapid drop in cases, so that the last three months of that year were free. The disease also decreased in intensity in other parts of the State, except in Baltimore County and in the City of Baltimore.

Chart 1 shows the incidence of rabies in Maryland during 1946. It will be noted that only two cases occurred in Prince George's County where vaccination programs had been used in 1944, 1945, and 1946; that two cases were diagnosed in dogs in Howard County; and that 20 cases were found in Baltimore County and 20 in the City of Baltimore.

Because the disease seemed to be on the increase in Baltimore County, despite continued quarantine restrictions, it was decided to include vaccination. Election District Nos. 1, 9, and 13, lying adjacent to the City of Baltimore, were set up on a clinic basis and injections were made during the period from April 29 to June 14, during which time 2731 dogs were treated. Increased efforts of County police at quarantine enforcement and of the County Humane Society in picking up ownerless and stray dogs were also put forth. It will be noted from the chart that three cases had been diagnosed in April, four cases in May, and during the time of the clinics in June one rabid dog was found in these districts, and that no cases appeared from that time until October, when one unvaccinated dog developed the disease. No cases have been seen in November.

The chart also shows that rabid dogs were found in sections of the City of Baltimore this year, the greatest number in any month being diagnosed in August. Quarantines had been in effect in several sections during all of this time. The cases in August occurred in only one area, and this was put under further restriction from September 20 to December 20. Increased vigilance of police in enforce-
ment and of the S.P.C.A. in the pick-up of ownerless and stray dogs was stimulated by the City Health Department and the Live Stock Sanitary Service. The use of a vaccination program was considered for this area; but it was decided, because of local conditions, not to resort to this procedure unless it became absolutely necessary. One rabid dog was found on October 31 and another on November 7, both of which required mouse inoculation tests for confirmation.

The introduction of rabies into Maryland in 1943 appeared in the main to have been the result of spread from the District of Columbia, which area had been affected by adjacent infected sections in Virginia across the Potomac River. It was pointed out in the report of 1945 that a vaccination program, combined with a leash order, had been put in effect in the District of Columbia. Following the completion of the injections, the disease decreased markedly. The vaccination and leashing program was continued in the summer of 1946. District Health Department officials have reported that no cases have been found during the four months following the completion of the injections.

Rabies control programs in Maryland from the spring of 1943 until the present have consisted of dog quarantines alone and of dog quarantines combined with dog vaccinations. It has been noted in previous papers that the enforcement of the quarantine restrictions was subject to great variation, depending on the local law enforcement agencies and the people upon whom the restrictions had to be imposed. These variations were present in areas where vaccination was not used, with the same frequency as in sections where vaccination programs were put into effect. There was definite evidence of beneficial effect of vaccination under conditions of good quarantine enforcement, as well as where quarantine restrictions were not fully enforced.

The results of experimental trials, using single-dose injections of dogs in rabies outbreaks, in combination with quarantine restrictions under varying degrees of enforcement, lead to the conclusion of sufficient efficacy to warrant the inclusion of vaccination in complete rabies eradication programs.
REPORT OF THE COMMITTEE ON RABIES


Statistics collected by the Bureau of Animal Industry of the U. S. Department of Agriculture for the calendar year 1945 have been made available to this committee.
### Table 2.—Rabies in the United States by states during the year 1945

<table>
<thead>
<tr>
<th>STATE</th>
<th>DOGS</th>
<th>CATTLE</th>
<th>HORSES</th>
<th>SHEEP</th>
<th>SWINE</th>
<th>CATS</th>
<th>GOATS</th>
<th>MISCELLANEOUS</th>
<th>MAN</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>655</td>
<td>19</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>28</td>
<td>0</td>
<td>Mule 1</td>
<td>3</td>
<td>714</td>
</tr>
<tr>
<td>Arizona</td>
<td>88</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td>0</td>
<td>Fox 7</td>
<td>0</td>
<td>122</td>
</tr>
<tr>
<td>Arkansas</td>
<td>153</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>0</td>
<td>Various 18 species*</td>
<td>1</td>
<td>187</td>
</tr>
<tr>
<td>California</td>
<td>534</td>
<td>27</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>2</td>
<td>Mule 1</td>
<td>1</td>
<td>582</td>
</tr>
<tr>
<td>Colorado</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Not stated</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Connecticut</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Not stated</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Delaware</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Not stated</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>District of Columbia</td>
<td>107</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>Rabbit 1 2 species*</td>
<td>0</td>
<td>109</td>
</tr>
<tr>
<td>Florida</td>
<td>247</td>
<td>17</td>
<td>4</td>
<td>0</td>
<td>7</td>
<td>4</td>
<td>3</td>
<td>Various 119 species*</td>
<td>5</td>
<td>701</td>
</tr>
<tr>
<td>Georgia</td>
<td>471</td>
<td>35</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>67</td>
<td>0</td>
<td>Various 10 species*</td>
<td>3</td>
<td>486</td>
</tr>
<tr>
<td>Idaho</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Squirrel 1 4</td>
<td>0</td>
<td>84</td>
</tr>
<tr>
<td>Illinois</td>
<td>417</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>42</td>
<td>0</td>
<td>Skunks 3 cats 4</td>
<td>0</td>
<td>53</td>
</tr>
<tr>
<td>Indiana</td>
<td>335</td>
<td>17</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>19</td>
<td>0</td>
<td>Skunk 1 3</td>
<td>2</td>
<td>385</td>
</tr>
<tr>
<td>Iowa</td>
<td>40</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>2</td>
<td>15</td>
<td>0</td>
<td>Fox 8 3 Raccoon 1</td>
<td>0</td>
<td>107</td>
</tr>
<tr>
<td>Kansas</td>
<td>81</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>0</td>
<td>Various 45 species*</td>
<td>3</td>
<td>1,000</td>
</tr>
<tr>
<td>Kentucky</td>
<td>43</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>Fox 3 16</td>
<td>0</td>
<td>144</td>
</tr>
<tr>
<td>Louisiana</td>
<td>875</td>
<td>40</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>26</td>
<td>1</td>
<td>Various 119 species*</td>
<td>5</td>
<td>485</td>
</tr>
<tr>
<td>Maine</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Fox 5 3</td>
<td>0</td>
<td>77</td>
</tr>
<tr>
<td>Maryland</td>
<td>68</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>Fox 0 3 144</td>
<td>0</td>
<td>144</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Fox 10 3</td>
<td>0</td>
<td>178</td>
</tr>
<tr>
<td>Michigan</td>
<td>119</td>
<td>5</td>
<td>16</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>Various 119 species*</td>
<td>5</td>
<td>485</td>
</tr>
<tr>
<td>Minnesota</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Fox 1 3 144</td>
<td>0</td>
<td>144</td>
</tr>
<tr>
<td>Mississippi</td>
<td>209</td>
<td>5</td>
<td>21</td>
<td>1</td>
<td>0</td>
<td>13</td>
<td>1</td>
<td>Fox 8 3 256</td>
<td>0</td>
<td>178</td>
</tr>
<tr>
<td>Missouri</td>
<td>150</td>
<td>5</td>
<td>15</td>
<td>1</td>
<td>0</td>
<td>17</td>
<td>0</td>
<td>Raccoon 1 3</td>
<td>0</td>
<td>178</td>
</tr>
<tr>
<td>Montana</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Fox 9 4</td>
<td>0</td>
<td>144</td>
</tr>
<tr>
<td>Nebraska</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Cevet 1 3</td>
<td>0</td>
<td>144</td>
</tr>
<tr>
<td>Nevada</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Cevet 1 3</td>
<td>0</td>
<td>144</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Cevet 1 3</td>
<td>0</td>
<td>144</td>
</tr>
<tr>
<td>New Jersey</td>
<td>48</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>Fox 1 3 144</td>
<td>0</td>
<td>144</td>
</tr>
<tr>
<td>New Mexico</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>Fox 9 4</td>
<td>0</td>
<td>144</td>
</tr>
<tr>
<td>New York State</td>
<td>488</td>
<td>85</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>15</td>
<td>0</td>
<td>Fox 49 1 644</td>
<td>1</td>
<td>644</td>
</tr>
</tbody>
</table>
Table 2—Continued

<table>
<thead>
<tr>
<th>STATE</th>
<th>DOGS</th>
<th>CATTLE</th>
<th>HORSES</th>
<th>SHEEP</th>
<th>SWINE</th>
<th>CATS</th>
<th>GOATS</th>
<th>MISCELLANEOUS</th>
<th>MAN</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York City</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>North Carolina</td>
<td>276</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>0</td>
<td>Fox</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>North Dakota</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ohio</td>
<td>705</td>
<td>48</td>
<td>5</td>
<td>1</td>
<td>26</td>
<td>1</td>
<td>Fox</td>
<td>26</td>
<td>2</td>
<td>814</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>98</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>Rat</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Oregon</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>737</td>
<td>56</td>
<td>6</td>
<td>0</td>
<td>2</td>
<td>38</td>
<td>0</td>
<td>Various</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>South Carolina</td>
<td>115</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>Fox</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>South Dakota</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tennessee</td>
<td>423</td>
<td>14</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>20</td>
<td>2</td>
<td>Fox</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Texas</td>
<td>831</td>
<td>24</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>40</td>
<td>0</td>
<td>Not stated</td>
<td>5</td>
<td>904</td>
</tr>
<tr>
<td>Utah</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>Vermont</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Virginia</td>
<td>82</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>Fox</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Washington</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Not stated</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>West Virginia</td>
<td>64</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>Fox</td>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Fox</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Wyoming</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>8,505</td>
<td>487</td>
<td>46</td>
<td>11</td>
<td>30</td>
<td>466</td>
<td>10</td>
<td>373</td>
<td>35</td>
<td>9,963</td>
</tr>
</tbody>
</table>

* Includes coyote, fox, rabbit, mouse, gopher, ground squirrel, rat, squirrel, skunk, wild cat, raccoon, opossum, and muskrat.

through the courtesy of the Chief of Bureau, B. T. Simms. There was a total of 9,963 cases reported. (See the attached map.) Table 1 gives the incidence of rabies in the United States as collected by the Bureau of Animal Industry since 1938.

A report on rabies and its control was issued November 26, 1945, by the National Research Council, Washington, D. C. It was prepared by a Subcommittee on Rabies of the Committee on Animal Health. It was also published in the May 1946 issue of the Journal of the American Veterinary Medical Association. The report is a comprehensive, authoritative discussion on rabies and includes recommendations for the control of the disease in the United States. This article should be in the hands of all livestock sanitary officials and practicing veterinarians.

No action has been taken on the bill HR 3289 which was introduced in the House of Representatives May 22, 1945, amending certain Acts, under which the Bureau of Animal Industry of the United States Department of Agriculture operates, to include within their provisions dogs and other domestic carnivora. Similar legislation will again be introduced into Congress at its next session. It is neces-
sary that such legislation be enacted for the Bureau of Animal Industry to par-

ticipate in a rabies control program on a national basis.

This committee desires to endorse the report of the Special Rabies Committee

of the American Veterinary Medical Association for 1946, referring particularly
to the recommendation that a meeting be called of representatives of the American
Medical Association, the American Public Health Association, the U. S. Public
Health Service, the U. S. Live Stock Sanitary Association, the U. S. Bureau of
Animal Industry, the American Animal Hospital Association, and the American
Veterinary Medical Association, to draw up definite plans for procedures for a
rabies control program on a national basis, and that when such a satisfactory
program has been drawn up that it be submitted to the representative organizations
for their approval and that it be then submitted to the dog-owning public through
the various dog associations and the public at large.

It is recommended:

1. That the Committee on Rabies be continued.

2. That authorization be granted for the attendance of one or more represen-
tatives of the U. S. Live Stock Sanitary Association to represent this association
if and when a meeting of representatives of the organizations mentioned is called.

3. That this association go on record as approving legislation necessary to enable
the U. S. Bureau of Animal Industry to participate in cooperation with the several
States in programs for the control of rabies.

Table 2 gives the number of cases of rabies in each State by species.
REPORT OF COMMITTEE ON BIOLOGICS


The members of your Committee have reviewed the previous reports made by the various Committees on Biologics since such Committees were appointed by this Association. We would recommend that everyone interested in the questions pertaining to biologics read these reports also, as well as the article, 'Wherein Is The Virus-Serum-Toxin Law Inadequate For The Proper Control of Veterinary Biologics' by Dr. D. I. Skidmore, in the annual report of this Association for 1940.

It seems evident under the current laws and regulations, that few, if any, changes can be made in the distribution of such products when once they enter the channels of trade. The concept of the free movement interstate of any commodity that is produced under federal license and federal jurisdiction is a basic part of the federal law, and it is unlikely that an exception could be made in the distribution of biologics without, at the same time, making an exception of many other types of commodities, and this would cause great confusion.

It is the feeling of your Committee, as it was the expressed feeling of previous Committees, that there should be definite restriction on the interstate movement of live virus and vaccines capable of setting up new centers of infection and of agents that are capable of changing the reaction of animals upon which indemnity is offered should they prove positive to a particular test. While recognizing the desirability of such restrictions, we feel that it is unlikely that this can be done without a change in the federal laws and regulations.

We wish to do no more at this time than to call to the attention of the proper authorities that the unrestricted distribution of such products endangers the programs for the control and eradication of animal and poultry diseases in the various states. It is a legal problem which we feel sure is recognized by federal officials, and is receiving proper attention.

Since the end of the war, attention has again been directed toward the efficiency of the various biologics used in the prevention and treatment of poultry and animal disease. Several biologics for the prevention of disease have been proved to be efficient and economical. There are others, however, including several mixed bacterins, presumably used for the prevention of disease in domestic animals and poultry, which appear to be questionable in their value. The organisms used in such mixed bacterins are similar to those usually found in bovine mastitis, infectious keratitis, enteritis in various species, and similar infections.

Because of the questionable value of such products, it is not permissible to put anything on the label which refers to the specific disease. They must be designated only by a formula and number and a listing of the proportion and type of the organisms used in preparing the bacterin. From time to time the value of these
products has been seriously questioned or openly condemned by qualified investi-
gators, but they are sometimes staunchly supported by others.

It would seem to your Committee that the efficiency and value of all biologics
licensed for manufacture and sale by the federal government should have definite
proved value. Your Committee, therefore, recommends that the President of
this Association appoint a committee to meet with representatives of the American
Veterinary Medical Association and the Bureau of Animal Industry to study this
problem.

We would further suggest that the representatives of these various agencies
consider the desirability of appointing a committee of qualified investigators to
determine the value of the various mixed bacterins, and to publish their findings.
On the basis of these findings it is quite probable that those of value can be used
with confidence, and those of little, if any, value be eliminated.

Your Committee feels that such an orderly and unbiased approach to this problem
is one step in the right direction in clarifying one of the problems pertaining to
biologics.
REPORT OF THE COMMITTEE ON POLICY


The U. S. Livestock Sanitary Association Committee on Policy for the years of 1940 and 1941 outlined the duties of the Committee. One recommendation which was adopted reads as follows:

"Your Committee further recommends that all matters of policy and all recommendations made by members of this Association be referred to the Committee on Policy, whose duty it shall be to study, prepare and present for the consideration of the Executive Committee all policies of a general nature affecting this Association."

Your present Committee begs to report that there have been no recommendations referring to policy received by the Committee during the past year.

The following recommendations, while not strictly relating to policy, are presented by your Committee on Policy to the Executive Committee:

1. We recommend that the Constitution and By-Laws of the U. S. Livestock Sanitary Association be printed in small pamphlet form, and that this pamphlet also contain the recommendations of the Committee on Policy which have been adopted by the Association.

2. Inasmuch as a Department of Vital Statistics has not been created by the U. S. Bureau of Animal Industry and as most state regulatory officers are left in the dark relative to actual disease conditions within the United States, your Committee on Policy recommends that regulatory officers of each state report, each quarter of the year, to the Secretary-Treasurer of the U. S. Livestock Sanitary Association a brief summary of disease conditions in his state, and that the Secretary-Treasurer have such reports mimeographed and a copy forwarded to each member of the Executive Board.

3. Your Committee again recommends that the various committees of the Association follow up their recommendations and that every effort be made by the officers of the Association and the various committees to have such action as may be necessary to have recommendations adopted and followed both by the individual states and such departments of the U. S. government as may be involved.”

45
REPORT OF COMMITTEE ON COMMUNITY AUCTION SALES


The livestock auction of today is a permanent institution rendering a valuable service to the livestock industry and the community it serves. Its growth and development have been gradually taking shape for many years. Of the many factors entering into its development, the rapid improvement in methods of livestock transportation has been the most significant.

The first major change in livestock marketing took place when the railroad came into prominence. With the establishment of shipping yards along their right-of-way, the early methods of droving cattle and transportation by water became obsolete. For a long period of time the principal movement of livestock to the slaughtering centers was by rail. The railroad as well as the terminal stockyards did a flourishing business.

The next major change came with the establishment of good roads and rapid improvement in motor vehicles. The movement of livestock by truck has made deep inroads in transportation by rail, and the railroads have keenly felt the change, and evidence of this is the abandonment of many of their shipping yards. Terminal markets have also felt the change. Out of these changes in methods of transportation, and with the trend of recent years for direct marketing of livestock, came the livestock market or community sale.

The community sale has been charged with many evils. They have been the source of the spread of hog cholera and other swine diseases, scabies in sheep, and brucellosis in cattle. Sanitation in some of the markets has been deplorable. Cleaning and disinfection were not given a thought. In some instances the construction of the building was such that cleaning and disinfection were impossible. Some markets have failed to keep accurate records of consignments which made it impossible to trace the origin of diseased livestock.

To correct the evils charged to the livestock auction, your Committee on Community Auction Sales offers the following suggestions:

THE AUCTION MARKET

1. A law providing for an annual license, with reasons for refusing to grant or revoke a license when:
   (a) A licensee or other applicant has violated the laws of the state or regulations governing the inter or intra-state movement of livestock.
   (b) False or misleading statements as to the health or physical condition of the animals with regard to official tests.
   (c) A licensee or applicant has engaged in buying, receiving or selling animals known to be diseased or exposed to communicable disease.
   (d) Measures of sanitation, disinfection and inspection have not been practiced.
   (e) When the licensee fails to have the scales tested once every six months.
(f) When the licensee fails to keep records or refuses to produce records of transactions. (It is often necessary to have access to records to determine the origin of livestock in tracing the source of disease.)

(g) When the licensee sells livestock owned by himself or in which he has monetary interest without first announcing publicly that such livestock is owned by himself or that he has a monetary interest in such livestock.

2. The posting of a bond to assure payment for the purchase or sale of livestock in case of a default. In theory the livestock producer, who consigns his livestock to an auction market or sells to a dealer, is assured payment for his livestock. In actual practice, where defaults have occurred, the bond has been inadequate in amount to cover the amount of default, and the livestock producer has suffered considerable loss. Therefore, the posting of a bond has not served the intended purpose of protecting the livestock producer.

In Ohio the amount of bond ranges from the minimum of $2,000 to the maximum of $15,000. It is obvious that a market posting a maximum bond of $15,000 and doing a weekly business of from $20,000 to $100,000 could not assure their patrons payment for the proceeds of livestock in case of a failure or default. In view of this, a bond would not serve the purpose for which it was intended unless the amount of bond was commensurate with the volume of business transacted. Therefore, the posting of an inadequate bond would be sheer mockery.

3. The licensing of each person weighing livestock. Provision to revoke a license for giving a false certificate of weight or for accepting, directly or indirectly, money or other consideration for improper performance of duty.

4. Testing of scales under supervision of the state every six months, to assure accurate weights.

An accurate test on heavy duty scales up to 10,000 pounds may be accomplished by placing test weights up to 2,500 pounds on each corner, which is the actual capacity of any corner, and adjusting any error that may occur.

5. The system of the market operator paying the veterinarian for inspection service is not conducive to the best interests of all parties concerned. Either the veterinarian should be in the direct employment of the state, or some system adopted whereby the market operator would collect a fee on the per head basis for inspection service, and the money so collected paid to the state, which in turn would pay the veterinarian.

6. The inspection of livestock before being unloaded at the market is recommended. Such inspection to include a history of the animals to find out whether they originated directly from the farm or have been jockeyed from sale to sale. Such history is especially valuable in the case of feeder pigs which go back to the farm, in alerting the veterinary inspector for diseases in the incubative stage.

7. The vaccination of all swine sold for purposes other than immediate slaughter, except those accompanied with an official certificate of vaccination. The dosage of serum and virus should be increased at least 25 per cent more than the minimum dosage prescribed on the bottle label, and may be further increased at the discretion of the veterinary inspector.

8. Bang's disease test on all cattle over six months of age, except those for immediate slaughter and steers for feeding purposes.
Any reactors found to be sold only to slaughtering establishments where official meat inspection is maintained and to be removed from the premises only on official permit.

9. Pens set aside and apart from those used for other cattle to be designated as quarantine pens. Such pens marked “Quarantine Pens” with letters at least four inches high. Such pens to be used only for handling “reactors” or diseased cattle.

When reactors are sold through the auction they should be the last in order of cattle sold, and the auction ring or scales should be cleaned and disinfected under the supervision of the veterinary inspector before the next sale, when such facilities have been used.

10. The veterinary inspector to quarantine all diseased or exposed animals either on the premises or back on the farm depending on existing conditions. In the event the quarantined animals are in a marketable condition, the veterinary inspector should have authority to order such animals sold for immediate slaughter. Such animals, when sold, should be consigned directly to a slaughtering establishment within the state which maintains official meat inspection, and removed only under an official removal permit.

11. The identification by tag of all swine sold through the sale for purposes other than immediate slaughter. Such an identification is a protection to the purchaser.

12. Cleaning and disinfection before each sale is held. Such cleaning and disinfection should be under the supervision of the veterinary inspector. A power sprayer should be used. There should be an adequate supply of water at all times to assure proper spraying.

13. Cleaning and disinfection of all trucks which have hauled diseased or exposed livestock and those found in a dirty or filthy condition. The cleaning and disinfection to be under the supervision of the veterinary inspector, and done before the truck leaves the premises of the auction market.

Litter and manure from contaminated trucks and premises should be disposed of in such manner as to prevent exposure or contact to livestock.

14. Floors of pens and alleys used for swine sold for purposes other than immediate slaughter should be constructed of concrete or similar impervious material. Floors should have sufficient slope to afford proper drainage and be provided with appropriate drains leading to an appropriate drainage system.

15. The premises of the auction market should be maintained in a clean, orderly and sanitary condition at all times.

16. Floors of cattle pens to be constructed of concrete, gravel, crushed rock, or coarse sand so that the animals will not stand in manure or mud during inclement weather.

17. The veterinary inspector should be provided with office space in which to make out certificates and records of tests. He should also be furnished suitable facilities for the handling and treating of swine. A copy of each certificate and record of test and quarantine issued should be forwarded immediately after each sale to the state veterinarian.”
REPORT OF COMMITTEE ON LEGISLATION


Under date of February 5, 1945 the Hon. Edward H. Rees, Congressman representing the 4th District of Kansas, introduced HR 1986 into the House of Representatives, which was referred to the Committee on Agriculture. This bill was intended to amend the basic Act of May 29, 1884, creating the Bureau of Animal Industry within the U. S. Department of Agriculture. The original Act was limited in scope, referring specifically to preventing the exportation of diseased cattle, and the suppression of contagious pleura-pneumonia and other communicable diseases of domestic animals.

The purpose of the bill HR 1986 introduced by Congressman Rees in the 79th Congress was to broaden the scope of the original Act and to empower the Secretary of Agriculture to extend his authority to include "dogs, other carnivorous animals whether domestic or wild." The object of this proposed legislation, among other things, is to permit the adoption of means for the suppression of rabies.

The report of the National Research Council's Subcommittee on Rabies discloses an alarming increase in the prevalence of this disease in the United States. Such a condition is evidently due to a lack of adequate control measures. As shown by the report, rabies occurred among several animals—dogs, cattle, horses, sheep, swine, cats, goats and other animals, including man. The Council reported a total of 7,238 cases in 1940 and 10,540 cases in 1944.

In view of the threatening increase of the incidence of rabies, which would cause serious economic loss to our nation through animal mortality, we urge legislation to enable the federal Bureau of Animal Industry to coordinate nationwide control measures.

The present economic conditions of advanced living costs and better opportunities in other veterinary fields are tending to cause veterinarians to leave the Bureau of Animal Industry employment due to the comparatively lower remuneration. Also, the present level of salaries is inadequate to attract a sufficient number of young, qualified veterinarians to enter the Bureau service. For these reasons we recommend that the Congress be urged to give all possible aid by the granting of sufficient appropriation of funds to provide adequate salary increases. We believe the loss of qualified personnel of the Bureau will eventually serve to lessen the effective protection of the nation's livestock industry.

We request that this Association petition the Congress to appropriate sufficient funds to the Bureau of Animal Industry for extended research and investigation, particularly of Newcastle disease, as well as other contagious diseases.
REPORT OF THE COMMITTEE ON ANAPLASMOSIS


Your committees on anaplasmosis have in the past presented some of the history, cause, symptoms and lesions, treatment, vectors and some of the short-comings in our knowledge how best to cope with this disease. Undoubtedly the latter is the most important chapter in the drama of this disease that requires strengthening.

It is of course a matter of history that the so-called fever bearing tick, *Margaropus annulatus*, simultaneously transmitted, with a single bite, both piroplasmosis and anaplasmosis but due to the fact that the tick did not long spare the new born calf, and since the young animal never showed manifestations of the disease, both diseases remained unrecognized in the tick infected area for many years. The symptoms of piroplasmosis and anaplasmosis, together previously known as Texas Fever, only became known when a ticky cow strayed beyond the realm of the fever bearing tick long enough for some of the maturing ticks to drop from the cow and lay their eggs. When the eggs hatched and the larvae attached to mature cattle in the previously tick-free area these mature cattle all sickened and many of them died. But when the larvae attached to calves the latter did not show symptoms of Texas Fever.

The field of action of the tick on the ground was very limited and he had to attach to the cow to sustain life and thus he fell an easy prey to man's ingenuity. With the eradication of the tick it was thought that the matter was settled forever because, for many years, cattle freed of the tick mingled freely with cattle north of the original tick quarantine line without Texas Fever developing among them. In the tick infested area all cattle were carriers of *Anaplasma marginale* and remained so forever. Every calf dropped after the tick was eradicated grew up a susceptible animal and yet for many years anaplasmosis was not recognized as occurring in susceptible animals in this area, although the carrier animals were in the majority.

Now, what is the actual prevalence of anaplasmosis in this area today? On the surface it appears as though the cattle industry were flourishing in this particular area.

When anaplasmosis was finally recognized in this country, the scientists spared no effort trying to determine which ticks can transmit the disease sometime with very little regard as to whether or not the cow was the normal host of the tick under investigation or at least frequently or only rarely. Last year the committee presented a list of 19 species of ticks that are capable of transmitting the disease but only 10 of these occur in the United States. Two of these, *Margaropus annulatus* and the Australian cattle tick only occur in restricted areas in Florida and along the Mexican border in Texas under such close surveillance that they are not of importance in the transmission of anaplasmosis. Of the remaining 8 species only 4 occur frequently on cattle. Of the latter 4 species 2 do not occur in the south or southwest and the area occupied by one of these species is not known as an anaplasmosis area in Texas.
The situation is different with respect to the flying, biting insects. Those listed last year are all vicious biters but here again an uneven distribution prevails. Perhaps the tabanidae are the most uniformly distributed and most frequently the vectors involved. But even here transmission does not occur every time a fly interrupts its feeding on a carrier animal and continues on a susceptible animal as those of us who have spent many hours trying to accomplish transmission in that manner can testify. Transmission can, however, be readily accomplished in that manner in case the fly has been feeding on an acute case of anaplasmosis and experience shows that in outbreaks of anaplasmosis the transmissions apparently all occurred within a limited period of time, corresponding to the duration of an acute attack of anaplasmosis. Undoubtedly insect transmissions occur from carrier animals but the flare-ups usually follow an acute case of anaplasmosis corresponding to the period of incubation of the disease, roughly 30 days. In many areas man probably is the vector who transmits the original case of an outbreak.

At present anaplasmosis is reported from 27 States which indeed covers a formidable area but the extent of the ravages of the disease within this area can not be found in available records. In at least two States only a single outbreak has been observed some years ago and it is possible that this is also true of some other States. Unless in such cases more serious consequences are observed in the future, the outbreak did not amount to more than having lost so many cows, let us say from acute bloat, because eventually the carriers will be eliminated from the herd. It is desirable that, on this point, more information be gathered and carefully considered in any rules and regulations formulated in dealing with this disease. For this purpose a more careful study of the actual mode of spread and behavior of the disease within a herd and from herd to herd is also sorely needed. Its spread is readily understandable when the next prospective victim belongs to the same herd and is close at hand, but it is not so readily understandable when the next victim belongs to a different herd and is not so close at hand. In this case the answer must also satisfy the question, how far does a horsefly fly or how often does a horsefly interrupt its feeding to immediately embark upon a cross country flight? In case a tick is the vector then the carrier cow will have to get to the next herd. It is important to have these answers in order to intelligently formulate means of control that will accomplish their purpose with justice and without undue hardships. They may also be the determining factor in the procedure open to the owner of the infected herd as is evident from the following considerations of what happens or may happen in such a herd. There is an undercurrent of suggestions in the writings on this subject that an outbreak of anaplasmosis in a herd is a serious threat to the cattle population at least in the community. This is rarely, if ever, the case. The outbreak rather remains confined to the premises of the infected herd. Frequently one of two animals came down to begin with, in case the disease is insect borne, and may or may not be followed some 17 to 30 days later by a number of other cases. In range animals many of the cases may escape detection because many animals will not show clinical symptoms until the disease is well advanced and unless seen during the short remaining period of the disease will not be detected. Neither will cases be detected in animals under one year old because such animals rarely manifest clinical symptoms. When the outbreak finally subsides the owner is con-
fronted with the following status of his herd. Either only those animals known to have recovered are now carriers or in addition some of the others also, but he has no means of determining which ones. Should he have another outbreak during the next year the process may repeat itself and if he keeps his herd long enough, especially when he replaces old females with young home grown animals, he may find himself the owner of a herd in which the majority of the animals are carriers and yet he may not know it. In such a herd the chances of an animal coming down with anaplasmosis decreases as the number of susceptible animals therein decreases. The resistance of the animals of such a herd to anaplasmosis rests on a basis of carrier animals only, that is, they are in a state of premunition.

Of many hundreds of young animals of European breeds inoculated by your chairman for the purpose of creating a state of premunition against anaplasmosis, he has never found one that was resistant to the inoculation and it stands to reason that no resistance exists in nature that does not have premunition as its basis. This state of affairs has prompted many a cattleman to ask why he should not inoculate all of his calves that he intends to keep as breeding stock but not those that he intends to dispose of as breeders. It is at this point that the argument starts and the cattleman has all the odds in his favor. When he asks the veterinarian which are the carrier animals in his herd he received the answer: "I do not know". And when he asks the veterinarian how much of menace his carrier animals constitute to his neighbor's herd his answer again must be: "I do not know", because at present we really lack the proof that would admit of a different answer. And if the cowman asks how come we have so few cases of anaplasmosis now, comparatively speaking, when at one time all our cattle south of the original Texas Fever line were carriers, the veterinarian is floored for the count of ten. Until you can go into this cowman's herd and point out the carrier animals so he can eliminate them with the assurance that he will suffer no more losses from anaplasmosis he may insist upon taking full advantage of any method that will offer him such assurance and more often than not his choice will be premunition of his young animals regardless of whether this is a long-sighted or short-sighted view to take. At present we have nothing better to offer him.

But that should not stop us from seeking a better method of control. We must diligently explore every angle of the problem that may affect our future point of attack. It is not enough to know that the most elusive of the vectors, the biting flies, can transmit the disease, but we must also learn how frequently they are responsible, how long after feeding the Anaplasma may remain viable on their proboscides, their habits of feeding and movements from animal to animal including movements from herd to herd for all have a bearing on the problem. We need to know where the infection came from and where it is likely to go from here. Careful observation may, weeks later, reveal the direction of flight of the guilty fly by the outbreaks of anaplasmosis occurring in its wake. Such information is needed to properly evaluate the extent to which these flies are responsible in transmitting and perpetuating anaplasmosis and how much emphasis must be placed upon their elimination.

1 Your chairman has found the Zebu breed highly resistant as far as the manifestation of clinical symptoms is concerned, but they all become carriers.
In short we need:
1. A closer study of the ecology and methods of control of all vectors of anaplasmosis with special reference to the discovery of new drugs that may prove effective in combating them.
2. An accurate laboratory method of diagnosis of carrier animals.
3. A diligent search for drugs that will effectively destroy Anaplasma marginale in the blood in both the acute and carrier state.
4. Collection of data in each State that will accurately reveal the extent of prevalence of the disease including number of herds, the number of animals affected in each herd annually, a record of the introduction of new animals into the affected herds, etc., so that a guide may be available to more accurately evaluate the true menace of the disease to our cattle industry.
NO VISIBLE LESIONS IN THE BOVINE, AND ITS RELATION TO AVIAN TUBERCULOSIS

BY C. E. FIDLER, M.D.C.

Superintendent, Division of Livestock Industry, Springfield, Illinois

In the process of tuberculosis eradication and control, all of us have received post-mortem reports of "no visible lesions" on animals which have shown a reaction to tuberculin and have been condemned to slaughter. Such reports seem more numerous as the lesion reports decrease.

It has been estimated that over the past fifteen years, from 1930 to 1945, there has been a reduction of approximately 86 percent in the typical lesion reports, with a 65 percent reduction in "no visible lesion" reports. Reports from other states set "no visible lesion" reactors from 88 percent on down.

I know all of us here will agree that the reactor to a tuberculin test showing "no visible lesions" presents an increasingly serious economic and sanitation problem. In coping with this problem, we have certain pathologic and serologic theories to consider:

1. To begin with, it has been contended that most tuberculin reactors showing "no visible lesions" upon autopsy have been previously infected with the bovine tuberculosis organism. Whether this is true or not, I do not know.

2. It has also been contended that there must be a tubercule prior to sensitization, that some lesion must be present upon macroscopic examination, perhaps so obscure or minute as to escape observation.

3. A theory of mutation, or transformation, has been advanced, claiming the transformation of the tuberculosis organism from one type to another. This applies particularly to the avian type of organism, its early presence sensitizing the bovine to tuberculin, causing the reaction to tuberculin when applied but presenting no visible lesions, later developing into the bovine type of the organism.

On the other side of the picture, theory has been advanced claiming that cattle are relatively immune to avian tuberculosis, the type commonly associated with our past "no visible lesion" reports. All of these represent theories relative to the cause of "no visible lesions" in tuberculin reactors. Nevertheless, they give us perspective in viewing the problem at hand.

Recently, an incidence of bovine tuberculosis in Illinois has provided us with an opportunity to study the subject of "no visible lesions" in the bovine and its relation to avian tuberculosis. We have a county here in Illinois which became accredited tuberculosis-free over twelve years ago. This county, when tested recently for re-accreditation, disclosed a fraction over 2 percent reaction. This county has been accredited on a 3-year basis with previous re-accreditation tests showing .31 per cent reaction in 1939, and .22 percent reaction in 1942. Needless to say, this sudden increase in infection in this county has caused great concern for both State and Federal officials and the herd owners of this and adjoining counties. The fact that all counties adjoining this county have had very few cases of tuber-
TUBERCULOSIS WITHOUT VISIBLE LESIONS

Tuberculosis made this "break" extremely puzzling. The highest percentage of infection in any county adjoining this one on the last reaccreditation test was .41 percent, and in looking for an explanation of this sudden and totally unexpected rise in reaction in this county a careful study of all the phases of the problem was begun. We studied the past tuberculosis history of this county and the individuals doing the field work on the various re-accreditation tests, as well as those doing the recent re-accreditation testing. Post-mortem reports were studied. Since there has been considerable dairy cattle traffic between the State of Wisconsin and the State of Illinois, investigation was made into the bovine tuberculosis incidence in the Wisconsin area from which most of the dairy cattle had been imported into this offending county. This investigation revealed a bovine tuberculosis incidence in the Wisconsin area of .04 percent, fifty-two percent of which had been "no visible lesion" reactors based upon the status of June, 1944.

Finally, a survey of as many poultry flocks as possible was made and studied. In this survey, it was our aim to test as many flocks as possible in the area which had shown heavy bovine infection, as well as areas showing no bovine infection, and an experienced avian tuberculosis man was assigned to the testing. The testing of flocks was not compulsory, and the voluntary submission of flocks to test in an area where there was resentment over having lost high-priced cattle interfered somewhat with our survey. Nevertheless, we feel that sufficient information was obtained in this survey to indicate that avian tuberculosis was not the sole cause of the "break" in this county, and not the sole cause of the "no visible lesion" tuberculin reactors found in this county. There were 76 flocks, consisting of 12,740 birds, tested in this survey, of which 61 flocks, containing 10,415 birds, were in the area of the heaviest bovine infection.

There were 36 of these 61 flocks found to contain avian tuberculosis reactors, and 25 negative flocks representing a flock infection of 59 percent. Of the 36 farms with infected flocks, 17 had bovine reactors at the time of this re-accreditation test. 19 had negative cattle. Of the 25 farms with negative flocks, 14 had bovine reactors at the time of this re-accreditation test. Eleven had no bovine reactors. It is interesting to note that of the farms with infected flocks, 47.2 percent had bovine reactors while 56 percent of the farms with negative flocks had bovine reactors.

---

**Chart I.—Stephenson County**

<table>
<thead>
<tr>
<th>Flocks tested: 61</th>
<th>Birds: 10,415</th>
<th>Reactors: 828, or 7.9%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flocks infected: 36, or 59%</td>
<td>Birds: 7,168</td>
<td>Reactors: 828, or 11.9%</td>
</tr>
<tr>
<td>Flocks negative: 25, or 41%</td>
<td>Birds: 3,247</td>
<td>Reactors: 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Farms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infected flocks (36)</td>
</tr>
<tr>
<td>Cattle positive: 17, or 47.2%</td>
</tr>
<tr>
<td>Cattle negative: 19, or 52.8%</td>
</tr>
</tbody>
</table>
The autopsy reports on the bovine reactors slaughtered from the area of survey showed as in chart 2.

From the farms having avian tuberculosis, there were four farms which had bovine reactors with "no visible lesions" only. From two farms, some of the bovine reactors showed lesions and some showed "no visible lesions." Of the bovine reactors from the 11 remaining farms, there were no "no visible lesion" reports. From the farms having no avian tuberculosis reactors, there were two farms from which bovine reactors with "no visible lesions" only were reported. On two farms, bovine reactors showed "no visible lesions" and skin lesions. On four farms, some of the bovine reactors showed "no visible lesions," some showed lesions. From the remaining six farms, the bovine reactors showed lesions with no "no visible lesion" reports. In other words, of the farms where avian reactors were found, 35.3 percent had "no visible lesion" bovine reactors and of the farms where no avian tuberculosis reactors were found, 57.1 percent had "no visible lesion" bovine reactors.

**Chart 2.—Stephenson County**

<table>
<thead>
<tr>
<th>Avian infected farms: 17</th>
<th>Avian negative farms: 14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactor cattle</td>
<td>Reactor cattle</td>
</tr>
<tr>
<td>N.V.L. only</td>
<td>4</td>
</tr>
<tr>
<td>N.V.L. &amp; skin l.</td>
<td>0</td>
</tr>
<tr>
<td>N.V.L. &amp; other l.</td>
<td>2</td>
</tr>
<tr>
<td>Skin or other l.</td>
<td>11, or 64.7%</td>
</tr>
<tr>
<td>Farms with N.V.L.</td>
<td>6, or 35.3%</td>
</tr>
</tbody>
</table>

It is realized that our survey covered only a comparatively few flocks and herds and is not sufficient upon which to base a definite conclusion as to a national or even a state situation. A more definite conclusion might have been reached had the previous history of the avian tuberculosis in these areas for the past three or more years been obtained, as well as some knowledge of the avian infection existing in the wild fowl.

The information to date, including our recent survey, certainly does not establish a workable relationship between the "no visible lesion" and avian tuberculosis. Our problem is still unsolved. In the light of this, we must continue our survey and studies on this subject. In this direction, always mindful of the theories previously presented, I think we should take into consideration the following:

1. Relative to the sensitization of the bovine by the avian and human strains of the tuberculosis organisms, we must suspect that the sensitization of the bovine by either of these strains is possible on the average farm and is no different today than in the past, with the exception of a possible reduction in bovine sensitization by the human strain due to a reduction in human infection. Experimental cattle have been infected with the avian strain and surveys on avian tuberculosis have disclosed that approximately 50 percent of the farm flocks in central Illinois are infected with avian tuberculosis yet the cattle on these farms apparently show no more infection than do those on farms with negative flocks. The percentage of "no
visible lesion” reactors from this area is no higher than in areas where the flocks are housed or fenced away from the cattle. The “no visible lesion” cattle react to tuberculin when used either in the intradermal or thermal test, the reaction being impossible to distinguish from those where typical tuberculosis lesions and skin lesions have been found.

2. In view of this, we must remember the theory previously mentioned regarding the mutation, or transformation, of the types of the tuberculosis organism.

3. I believe we should take into consideration the stage of incubation, or development, in tuberculosis in an attempt to correlate the reactions found after the injection of tuberculin with the post-mortem lesions reported after slaughter.

4. I believe we should consider the possibility of bovine sensitization by certain saprophytic, non-pathogenic organisms in the study of “no visible lesions.”

5. From a diagnostic standpoint, lesions have been the perfect score to officials and field men, and are never questioned. Skin lesions are questionable, but at least they are something to show. The “no visible lesion” report has been looked upon as a clean miss, an indication of inefficiency in either the field diagnosis or the post-mortem examination. It is hard for me to believe that there is no possibility for a post-mortem inspection to fail to locate lesions if they are present. We must not assume, in all fairness to meat inspection, that a report of “no visible lesions” means that the animal was not tuberculous. We must assume that it means exactly what it says—no visible lesions. Certainly, lesions that are not seen are not visible. During the period of the war, however, our inspection forces have been confronted with a serious problem. There has been a shortage of man power, many of the best men were taken into the armed forces. A large number of these men were not replaced. The replacements, as with the field forces, had not been thrown into contact with tuberculosis as were the inspectors of some years ago. This crew of men, working overtime at top speed, we must admit were more subject to missing some obscure lesion than would the men who were more experienced and not putting in the long hours demanded during the war emergency.

6. The field aspect has changed some. The older men, who have had opportunity to work with the test on large numbers of tuberculous cattle, are gradually dropping out of the picture and are being replaced by younger, inexperienced men. Although this has not made a vast change in the field situation, it may make more of a change in the future. Unfortunately, there are never enough tuberculosis reactors available to train the students while in college, and it is equally hard to find a sufficient number of tuberculosis reactors to demonstrate the various types of reaction when the student has been graduated to field work. Here we might feel a possibility of discrepancy in the injection of tuberculin and in the diagnosis of reactions found. We might feel that injections have been made improperly, causing localized areas of swelling simulating typical tuberculin reactions, which could account for some of our “no visible lesion” reports. In this line of thought we might consider the possibility of a correlation between certain types of reaction to the tuberculin test and the “no visible lesion” reports upon autopsy. Unfortunately, young veterinarians have not encountered a sufficient number of tuberculosis reactors, to take an animal about which they are in doubt out of a herd. As a whole, perhaps the replacement
veterinarians are much more dangerous to the livestock industry from the possibility of leaving reactors in a herd than from taking a clean animal.

As a counter to these possibilities, there are certain things of which we are reasonably certain:

1. We must assume that the cattle and the tuberculin are the same today as they were fifteen years ago, and should work as well together.

2. We have found, and probably will continue to find, “no visible lesion” reactors in tuberculin testing.

3. Lesions can not be established even by the most thorough and efficient post-mortem examination if they do not exist.

4. The percentage of “no visible lesion” reaction to tuberculin is increasing and, as shown by our survey, the relationship between the bovine “no visible lesion” reaction and avian reaction is inverse since the higher percentage of bovine “no visible lesion” reaction was found in areas of the lesser percentage of avian reaction.

5. The previous tuberculosis history of a herd is of little value, since true infection does occur in herds that have never had the infection. History should never take the place of a tuberculin test. The history of a herd that has not been tested for three years or more can not be depended upon since the owner’s memory is not, as a rule, accurate; especially in regard to additions that may have started to fail in health and were sold or died on the premises during the interval between tests.

In trying to arrive at the solution of a problem, we must consider all phases of that problem. We have begun a study of these phases in Illinois.

Just how serious is this “no visible lesion” problem? “No visible lesion” reactors have been figured for the most part on the basis of the number of tuberculin reactors on the assumption that a certain percentage of animals would react to the injection of tuberculin whether or not the disease were present, and this percentage would remain constant. One can naturally expect the proportion of “no visible lesion” reactors to increase per one hundred tuberculin reactors as the true tuberculosis infection is reduced. As a measure of the control of the disease, the percentage of reactors per number of cattle tested is used. Let us use the same measure in relation to the “no visible lesions.”

The percentage of “no visible lesions” per 100 reactors has increased from 12 percent in 1930 to approximately 32 percent in 1945. The tuberculosis reactors have reduced from 170 per ten thousand head tested in 1930 to 24 per ten thousand head tested in 1945. The “no visible lesions” per ten thousand head tested in 1930 were 20. In 1945, there were 7 per ten thousand tested, or .07 percent, an 86 percent reduction in reactors and a 65 percent reduction in “no visible lesions.”

The 7 “no visible lesion” reactors per ten thousand head tested is 29.1 percent of the tuberculin reactors. The average “no visible lesion” reactors for the past fifteen years has been 27.1 percent. Is this increase of two percent surprising when considering the stress on all concerned during the past four years?

If one were to assume that all of the “no visible lesion” reactors reported were free of the disease, would seven out of ten thousand be a serious margin of error? Have we any other test, or force of men applying any other tests, which will approach the efficiency of this test and these men?

It is my belief that if there were no such disease as tuberculosis in cattle there
would be a certain number that would react if injected with tuberculin. This situation will always exist in the tuberculin testing of cattle. It is realized that many “no visible lesion” reports are undesirable. It is realized also that one hundred percent lesions are undesirable. But from the standpoint of thinking cattle owners, “no visible lesions” are preferred to a lesion reactor, and far preferable to a reactor left in the herd.

If all reactors to the tuberculin test were “no visible lesion” reactors could we feel that we have bovine tuberculosis controlled?
CONSIDERATIONS IN THE CONTROL OF JOHNE'S DISEASE

BY HOWARD W. JOHNSON, B.S., M.S., D.V.M.

U.S.D.A., A.R.A., B.A.I., Animal Disease Station, Agricultural Research Center, Beltsville, Maryland

A growing interest in Johne's disease and its problems by veterinarians and livestock owners stimulated the writing of this paper. A foremost consideration in the control of this or any infectious disease is the elimination of primary infection sources, namely, the infected animals and the infected surroundings. It is, therefore, paramount to have an understanding of the infective agent (Mycobacterium paratuberculosis) both as to its behavior within the animal as well as in the animal's environment. This in turn necessitates developing a method which will identify infected animals, also an accepted procedure for eliminating or quarantining infected animals and removing environmental sources of infection.

CAUSE AND DISTRIBUTION

Johne's disease, or paratuberculosis, is a chronic infectious disease characterized by inflammation of the intestinal tract and mesenteric lymph glands, loss of condition, and diarrhea. Cattle and sheep are the more common host animals, however, goats, horses, and deer have been shown to be susceptible. Infection has never been known to occur in man. The infection has occurred in all sections of the United States, but apparently it is more prevalent and causes greater economic loss in the British Isles and continental Europe. As there is no accurate information available for evaluating its incidence in the United States, the Tuberculosis Eradication Division of the Bureau of Animal Industry is now endeavoring to gather more definite information on the extent and distribution of this disease.

The causative agent of Johne's disease (Mycobacterium paratuberculosis) is a small, aerobic, nonmotile, sporeless, and acid-fast organism which has a marked tendency to form clumps in the infected intestinal mucous membrane and mesenteric lymph glands. Cultivation is very difficult, requiring special media (1) and considerable time. After growing on special laboratory media for several generations, however, some strains of the organism become adapted to the media and grow satisfactorily. So far as is known, this organism does not multiply outside the body of a host animal.

MODE AND TYPES OF INFECTION

Attempts at infecting laboratory animals have met with little success. The primary seat of infection of Johne's disease being the intestinal mucous membrane of infected cattle and sheep means that large numbers of the causative organism may be present in the feces of diseased animals, and therefore, the diseased animal is always a potential source of infection to other animals. Exposure of susceptible animals may come from direct ingestion of fecal material from infected animals or by the ingestion of food or water contaminated with feces from infected animals.
It is generally believed and experiments have indicated (2) that young animals are more susceptible than mature ones and that the route of infection is through the digestive tract. The author has infected young calves by feeding the organism in cream, while failing to infect similar animals with the organism suspended in saline solution.

Infected herds may be classified into three types, (a) herds in which 10–25% of the mature animals annually show gradual emaciation and diarrhea, and die (7–10% of all herds containing reactors are of this type); (b) herds in which only an occasional animal will show clinical symptoms of Johne's disease and die (9–15% of all herds containing reactors are of this type); (c) herds in which there are animals which are sensitive to intradermal johnin and upon post-mortem show positive bacteriological and pathological evidence of Johne's disease but in which there has been no recognized clinical evidence. A large majority of herds containing reactors are of this type.

Months or even years may elapse following exposure before infected cattle show recognized clinical symptoms. Such animals thus may eliminate large numbers of the organisms in the fecal output and serve as spreaders before the disease becomes apparent.

**DIAGNOSIS AND TREATMENT**

Diagnosis of Johne's disease has always been difficult. As was previously mentioned, many infected animals that may be active spreaders of the disease show no clinical symptoms. Animals suffering from parasitism, malnutrition, and chronic intestinal disturbance may be mistaken as Johne's diseased. Microscopic examination of feces or scrapings from the rectum prove to be helpful in only about 25% of infected animals. However, both clinical and bacteriological examinations are helpful for herd diagnosis and should be used.

Avian tuberculin and johnin have been used as diagnostic allergens with encouraging results. Twort and Ingram (3), Hastings and Beach (4), Hagan and Zeissig (5), Johnson, Millegan and Cox (6) and Johnson (7) have reported favorable results employing one or the other of the allergens either subcutaneously, intravenously or intradermically. The experience of the author indicates that when a potent intradermic johnin is used, the intradermic test has several advantages over either the subcutaneous or intravenous tests, such as saving in time, ease of administration, and the finding of a greater percentage of infected animals.

Intradermic injections of 0.2 cc. of a johnin of high potency have resulted in local reactions in Johne's diseased animals comparable to those seen in tuberculous cattle following the intradermal injection of tuberculin. Intradermic injections should always be made on previously unused skin areas, at least four inches apart, and reading made 48 hours after the injections are made. The minimal enlargement (3 mm.) that is considered a reaction to johnin is smaller than that interpreted as a reaction in tuberculin testing, and the swelling also tends to be somewhat more diffuse than that in tuberculin reactors.

It is agreed by workers that animals that react to johnin or avian tuberculin, in a high percentage of cases are infected. The weakness in diagnosis with the tests is that an occasional infected animal fails to react.
It is also evident that many animals may react which are infected and are spreaders but which show no clinical symptoms.

Treatment of Johne's disease has proved to be entirely unsatisfactory.

POST MORTEM FINDINGS

The specific pathological alterations of Johne's disease involve only the digestive tract and mesenteric lymph glands. In young calves the entire small intestine may be involved, showing a picture of acute enteritis. However, the lesions are more frequently confined to the upper 2–6 feet of the intestinal tract in calves.

The lower portion of the small intestine, the cecum, and the upper third of the colon are the parts most commonly affected in adult cattle. In advanced cases the rectum may be involved. The changes in adult cattle indicate a chronic disease. The lesions may give a thickened appearance to the intestinal mucosa, with scattered inflammatory changes, and slight enlargement and an increased wetness of the mesenteric lymph glands. Acid-fast stained smears from either the involved intestinal mucosa or mesenteric lymph glands sometimes show large numbers of clumps of acid-fast organisms, while acid-fast organisms may be extremely difficult to demonstrate in smears from other infected animals.

It should be understood that thickening and fold formation in the intestinal mucosa are not in themselves confined to Johne's disease, nor does their absence rule out Johne's disease. Such changes have been found in the intestinal mucosa of many cattle which had passed johnin tests and in which M. paratuberculosis could not be demonstrated. The author has found it impossible to differentiate by macroscopic examination of the tissue between such lesions in cattle free of Johne's disease and those in affected cattle.

The microscopic pathological changes may be either (a) localized in the intestinal mucosa or (b) distributed throughout the intestinal wall, and may or may not involve the mesenteric lymph glands.

In type (a) the infection is generalized in the intestinal tract, but, as a whole rather definitely localized to the mucosa. However, isolated mononuclears containing organisms are found at times in the submucosa. The organisms are primarily present at the tips of the villi and, to a much lesser extent, involve the stroma; usually they occur in individual mononuclear macrophages but are also found in the cytoplasm of giant cells. Giant cells are present, but are not as great in number and their distribution in the tissues is much more erratic than are noted for animals included in type (b). Mononuclear macrophages are present throughout the mucosa and submucosa, but those in which organisms are found are confined to the tips of the villi and stroma.

Type (b) includes those animals in which the organism is much more invasive, and affects mucous, submucous, muscular and serous coats. There is a distinct difference in the type and site of the reaction at different levels of the gastrointestinal tract. In the region 20–30 feet posterior to the duodenum the reaction consists of monocytic and lymphocytic infiltration confined particularly to the tips of the villi. No giant cells and no organisms are visible at this level. Around forty feet posterior to the duodenum, the reaction consists of a very few giant cells embedded in the tips of the villi. No organisms are seen. At the fifty foot
level numerous giant cells containing organisms are seen in the villi; in addition, individual macrophages containing bacteria are seen throughout the mucosa and occasionally in the submucosa. In the cecum a very diffuse involvement occurs. Innumerable macrophages containing organisms are seen throughout the mucosa, submucosa, and serosa. There is usually a marked submucosal reaction including caseous foci, macrophage infiltration, destruction of the muscularis mucosa and perivascular reactions. Giant cells are numerous and contain organisms.

From the cecum posteriorly the reaction generally resembles that seen at the forty foot level.

CONTROL

It is a matter of common knowledge that Johne's disease is one which has a potential of becoming a major disease of cattle in this country. In individual herds it has been known to bring about an economic collapse of the herd owner. Unlike many other infectious diseases the primary infection is in young animals, later manifesting itself clinically particularly in young adults, although mature cattle may show clinical evidence from a disease condition which has been present in chronic form for years. Its onset and development are insidious and its course, whether to apparent recovery or death, is most often very long with resulting heavy economic loss and the accompanying danger of infecting healthy young cattle.

Since there is no known method of treating Johne's disease successfully, any effective control must consist in preventing exposure of susceptible, healthy animals. As intradermal johnin is still in the experimental stage, and because of a lack of knowledge on the economic potentialities of johnin reactors in herds without clinical Johne's disease, only in herds made economically unsound because of this infection have tests been made as a step toward eradication. The following procedure has proved successful in the limited number of herds in which we have worked.

All animals, regardless of age, should be tested with intradermal johnin as previously described. All animals showing 3 mm. or more increase in skin thickness at the 48th hour, should be classed as reactors and removed from the herd. Any animal in a doubtful status should be isolated until the disease status is determined. This will materially lower, if not eliminate, the continued contamination of the barns and pastures.

A survey should then be conducted of all buildings and pastures available to the animals. Written, detailed recommendations for cleaning, disinfection, and management should then be prepared and furnished to the owner. All stanchions, stalls, barns, pens, and corrals in which cattle have been housed should be thoroughly cleaned with hot lye solution and then all wood or concrete mangers, drinking troughs, and floors should be disinfected by soaking for several hours in sodium orthophenylphenate or some disinfectant approved for tuberculosis eradication work. Pens and corrals in which infected animals have been kept should be cleaned of all manure and at least 4 inches of the top soil removed and either buried or placed in a field to which cattle will not have access. This field should be so selected that drainage from it does not contaminate pastures, streams, other
sources of drinking water, or pens that may be used by healthy cattle. These precautions are especially necessary in controlling the spread of Johne's disease because of the long life of the *M. paratuberculosis* in soil. This organism is known to live in soil for well over a year.

After barn yards or corrals have been thoroughly cleaned, they should be regraded and filled with gravel or broken stone to provide good drainage. All low and wet places in lots and pastures should be drained or fenced off. All precautions should be taken to prevent fecal contamination of either feed or water supplied to healthy animals, especially calves.

Isolation of calves, *the most susceptible age*, should be continued and improved to the extent that very little chance of carrying infected material into their pens and lots is afforded. We have found that individual calf pens constructed of rough lumber are highly satisfactory. This pen is 7 feet long, 4 feet wide, and 4.5 feet high with a slatted floor 18 inches off the ground. Nippled calf feeding buckets are recommended for the first 4–5 months of life, with grain and hay made available to the calf after the first 3–4 weeks.

The calf is kept in its private pen, away from man-carried contamination for the first 5–7 months of life. The calf is then placed on a clean pasture, and remains there, away from the adult herd until freshening time.

One should realize that, because of the chronic nature of Johne's disease, the spread of the organism through fecal contamination, the susceptibility of calves, and the long life of the organism in the soil, it is one of the most difficult of the infectious diseases to eradicate and that eradication will probably require at least 2 years of constant vigilance. The mere removal of cattle showing clinical symptoms will not usually bring relief, for too many apparently healthy animals are potential spreaders of the organisms. Therefore, every 3 to 6 months retests and removal of reactor animals should be planned. At all times cases of diarrhea should be considered as suspicious and the animals segregated until their disease status has been determined.

Additions to a clean herd or one in which eradication is in progress, should of preference be made from herds previously tested with intradermal johnin and found to be entirely negative. If such cattle are not available, only cattle tested and found to be negative to intradermal johnin at the time, should be purchased. Upon arrival at the farm strict isolation should be observed until at least one additional negative intradermal johnin test is obtained. This test should be performed 3 to 6 months after the animal's arrival at the farm and on a previously unused skin site.

The veterinarian's responsibility in Johne's disease control or the control of any infectious disease has not been dispatched until time is spent to give understandable instruction to the farmer and his employees on matters concerning disease control. The people responsible for the care of the cattle, including the owner, the herdsman, and the laborers, must understand *the conditions that lead to infection and its control*. They should and must understand how the organisms of disease, and particularly in this case, *M. paratuberculosis*, operate in the body of cattle and exist outside the body. They must understand the *why* for each step suggested for the control of the disease, and that it is necessary, and that exceptions are apt to
void all the work and expense used in an effort to eradicate the disease. They must be shown that theirs is the chief responsibility and that no one can accept that responsibility for them.

REFERENCES


BOVINE TUBERCULOSIS—PAST, PRESENT AND FUTURE

BY J. ARTHUR MYERS, M.D.

School of Medicine, University of Minnesota

THE PAST

In reviewing the history of tuberculosis control among animals, particularly the cattle, of the United States, I am always intrigued by your far reaching vision, the objectives you early laid down, by the scientific approach of first establishing facts and your practical application of them. In diagnosis the veterinarians promptly grasped every new device, such as the stethoscope, clinical thermometer, microscope, tuberculin and the x-ray. Each one was given adequate trial. The stethoscope and clinical thermometer brought to light only evidence of extensive disease and did not differentiate between the etiological agents. The microscope was the first instrument to afford specific evidence of tuberculosis, as demonstration of tubercle bacilli from secreta and excreta usually made certain the diagnosis, however, the disease was already contagious and too extensive to be amenable to treatment when diagnosed in this manner. The x-ray was not found satisfactory because of the size of the animals, the extent of disease before it cast shadows, the impossibility of differentiating between various diseases from the shadows and the expense involved.

The tuberculin test offered the first ray of light in accurate and early diagnosis of tuberculosis. By this test the disease can be diagnosed within approximately a month after tubercle bacilli invade the tissues. Although the test is equally accurate in the diagnosis of later stages of the disease, its greatest practical value is in its ability to detect the presence of tuberculosis before there are any external manifestations or contagion. This can be accomplished by no other phase of the examination. When Koch produced tuberculin in 1890 the veterinarians promptly put it to the test. They did not speculate and theorize as to the meaning of a reaction but went directly to the bodies of the reactors and practically always found that tuberculous lesions were present, whereas in the bodies of the non-reactors no such lesions were in evidence. Thus the specificity of the test was promptly established. Thereafter a tuberculin reaction always meant the presence of tuberculous lesions containing living tubercle bacilli. This left no room for bickering over such fantastic subjects as the difference between tuberculous infection and tuberculous disease.

In any disease for which there is no specific chemotherapeutic agent the thought of artificially producing immunity looms high in the minds of the workers. When the tubercle bacillus was discovered effective immunization was in use for a few diseases, particularly smallpox. Therefore it seemed logical that an efficacious

1 Presented before the fiftieth annual meeting of the United States Livestock Sanitary Association, Chicago, Ill., December 4, 1946. From the School of Public Health, University of Minnesota.
immunizing agent could be found for tuberculosis. Although there was no substantial premise on which to work, inasmuch as an attack of the disease does not immunize against subsequent attacks, nevertheless numerous attempts were made to produce immunizing agents. Nearly always these were first tested on animals, and therefore it fell to the veterinarians and workers in experimental medicine to determine the efficacy of any and every so-called immunizing agent before recommending it for general use.

Tuberculosis long constituted a momentous problem among cattle, and therefore the veterinarians were ready to welcome any efficacious substance that might be quickly, easily and inexpensively administered. On the other hand, the majority of veterinarians were never gullible. They refused to accept a substance, no matter by whom it was prepared, or what claims were made for it until it had been subjected to the most rigid tests. In an experimental way they tried one immunizing substance after another only to discard them because their efficacy could not be proved.

One of the most important decisions the veterinarians have had to make concerning immunization came during the first decade of this century. The world famous Von Behring, a physician of Marburg, introduced what he called bovovaccination. To immunize humans he used living attenuated bovine type and to immunize cattle he used living attenuated human type of tubercle bacilli. He was so convincing in his claims regarding the efficacy of these substances that in 1902 he was granted the Nobel Prize at Stockholm for his address on the immunization of cattle. In 1904 the Prussian government constructed a royal institute against tuberculosis and placed it under his direction. He was so forceful, persistent and tenacious that large numbers of persons who were not students of tuberculosis became wildly enthusiastic and practically demanded that veterinarians employ bovovaccine everywhere to immunize cattle. This method became a law in such places as Mecklenburg and the Kingdom of Saxony. A firm of druggists in New York City sent to the owners of cattle in the United States a letter containing statements such as the following: "Von Behring seems to have solved the problem as to the suppression of tuberculosis in cattle. We therefore have to deal with facts and not with theories. The inoculation is especially opportune in calves and young heifers not exceeding the age of six months. Two inoculations will immunize them against tuberculosis for their lives. We furnish the vaccine and have it also injected by our veterinarians in order to be sure that it will be done properly.

The veterinarians of America were not as easily forced into the use of this substance as the drug company and the remainder of Von Behring's followers had hoped. They, as well as the veterinarians of Europe, put bovovaccine to the test and found it wanting. By 1912, except for a few stragglers with selfish motives, bovovaccine had been discarded. Just as the last evidence to complete the proof of the total inefficaciousness of bovovaccine was being established, Calmet came forth in 1908 with an attempt to attenuate the bovine type of tubercle bacillus to such a degree that it would not produce significant, progressive disease in living tissues. In 1913 he and his co-worker, Guerin, introduced this substance (since known as BCG) into the bodies of 10 calves. This experiment was interrupted by World War I. Soon thereafter, however, BCG was on the market, and the scientific veterinarians of the
United States Bureau of Animal Industry such as Schroeder, Cotton, Crawford and others gave it adequate trial over a sufficiently long period to prove that it was not helpful in controlling tuberculosis among the cattle of this country. Larson and Evans administered BCG to cattle and found that the supposedly vaccinated animals later exposed to contagious cases of tuberculosis in the same manner as the controls developed the disease just as frequently and as extensively as the controls. Watson of Canada conducted similar long-period experiments with BCG on cattle and found that it did not immunize.

As much as the veterinarians of the United States may have desired a rapid and easy method of controlling tuberculosis among cattle, they have never been lured into the use of any procedure whose efficacy could not be proved. Had this not been true, it is more than likely that the great accomplishment which they now enjoy would never have been achieved. If BCG had been administered to all the cattle of this country their tissues would have been rendered allergic to tuberculin protein so as to completely nullify the tuberculin test which more than anything else was responsible for their accomplishment.

Not all animals with tuberculosis, as manifested by the tuberculin reaction develop clinical lesions and become contagious. When this does occur, however, it is always among the tuberculin reactors. No specific therapy has been available to destroy tubercle bacilli in the bodies of animals, therefore the only practical solution of the problem is to find all animals as soon as possible after they become tuberculin reactors and promptly destroy them. To many persons who were not students of tuberculosis this seemed chimerical, impractical, a needless waste, a financial burden too great to tolerate and a danger to human health. They launched fierce opposition, personal attacks, et cetera, which retarded accomplishment. The veterinarians and their allies were students of the disease, they possessed the facts necessary to eradicate it, and unfalteringly they manifested the courage of their convictions. Despite the obstacles that were thrown in their way, they never lost sight of the goal—eradication.

After the District of Columbia demonstration proved that tuberculosis can be eradicated from the cattle of a political division the veterinarians again manifested their vision and willingness to work by the establishment of a national tuberculosis eradication campaign in 1917. Within twenty three years the disease had been so controlled in every state that the entire nation was designated a modified, accredited area, indicating that only 0.5 percent or less of the animals had tuberculosis as manifested by the tuberculin reaction. No group of tuberculosis workers either among animals or people had ever attained such a goal.

Your record of having done 25 million tuberculin tests upon the cattle of this country in a single year and 287,689,953 tests between July 1, 1917 and June 30, 1946 shows the immense confidence you have had in this test. The marked decrease of reactors, the reduction in the incidence of tuberculosis found at autopsy at the points of federal inspection between 1916 and 1946, has completely justified your confidence. In 1918 almost 5 percent of the animals tested in this country reacted to tuberculin, but by 1943 only 0.18 percent and in 1946 0.23 percent. In 1917 a total of 9,276,049 cattle were slaughtered under federal inspection, and 40,746 (0.3 percent) were condemned as inedible because of tuberculosis.
BOVINE TUBERCULOSIS

During the year 1944, 12,900,544 cattle were slaughtered, of which 1,435 (0.011 percent) were condemned for the same reason. Actually, in proportion to the number slaughtered, 98 percent less were condemned in 1944 than in 1917. Smith has pointed out that in 1916 tuberculosis found on postmortem at points of federal inspection resulted in condemnation of enough carcasses to equal a solid trainload of live cattle 15 miles long, whereas in 1945 the train was only 0.4 of a mile in length.

Between July 1, 1917 and June 30, 1946, 3,911,414 cattle were slaughtered in this country because they reacted to tuberculin. At no time did this materially reduce dairy products or the meat supply of the nation. On the contrary, it created a situation in which the owners could raise cattle and market both dairy products and beef with slight loss from tuberculosis. Indeed the accomplishments of the veterinarians and their allies had been so effective in tuberculosis control, as well as that of other diseases among cattle that throughout World War II there was no nation in the world so well prepared to produce safe dairy products and beef—not only for home consumption but also for the fighting forces of the United States and a number of other nations.

BOVINE TYPE OF TUBERCULOSIS IN PEOPLE

When Ravenell in 1902 recovered unmistakable bovine type of tubercle bacilli from the lesions of a child dead from tuberculous meningitis, a bitter controversy was being waged as to the virulence of the bovine type of tubercle bacillus in human tissues. Koch himself stoutly contended that it did not constitute a significant problem. As the years passed, however, overwhelming evidence accrued. The gravity of tuberculosis in man caused by the bovine type of tubercle bacillus was not well understood in this country by physicians in human medicine when your national campaign began. However, as more typing was done the magnitude of the problem became apparent.

The actual typing of tubercle bacilli removed from lesions of humans at surgical operations, autopsies, sputum, spinal fluid and the like, completely supported the early contentions of veterinarians that the bovine type of tubercle bacillus causes a great deal of serious tuberculosis in man. For example, Chang in Massachusetts (1933) found in 200 cases of extrapulmonary tuberculosis the bovine type of bacillus was responsible in 71 percent of patients from one to five years and 11 per cent in persons over 17 years. The average for all age periods was 27.5 per cent. In 1937, Griffith of Cambridge, England, pointed out that in his country approximately 50 per cent of lesions of the cervical lymph nodes and the skin, 25 percent of the cases of fatal meningitis, 20 percent of lesions in the bones and joints and genito-urinary tract and 1 to 6 percent of pulmonary lesions were caused by the bovine type of tubercle bacillus. Later Griffith and Munro investigated 6963 cases of pulmonary tuberculosis in Great Britain and found that 241 of them expectorating the bovine type of tubercle bacillus. In the same year Cutbill and Lynn investigated 2101 cases of pulmonary tuberculosis in a sanatorium and found that 2.28 percent were caused by the bovine type of bacillus. In 1942 Hedvall of Sweden published a monograph reporting 94 persons with the bovine type of tuberculosis. He demonstrated that tuberculosis of bovine origin in man shows
complete agreement with the corresponding forms due to the human types of bacillus. The only possibility of establishing the diagnosis is by typing the organisms as had also been found by Griffith. Thus the former belief that the bovine type of tubercle bacillus has a low virulence for man is untenable. Hedvall demonstrated that the bovine type of tubercle bacillus can be transmitted from cattle to man, from man to man, and from man back to cattle. To solve his problem he says it is imperative that the campaign against tuberculosis in cattle be carried on with the greatest energy and that the goal must be the extermination of these infected animals.

During the first few years of the recent war in England there was a relative increase of 50 percent in tuberculous meningitis among children up to the age of 10 years. The Committee on Tuberculosis in Wartime of the British Research Council pointed out that city children previously supplied with pasteurized milk were evacuated to the country where they consumed raw milk. Examination of milk from individual herds showed that an average of over 6 percent of all farms were producing milk containing tubercle bacilli. Moreover the bulk milk which was sold represented the mixed milk of 20 or more herds. Therefore nearly all bulk milk was contaminated with bovine type of tubercle bacilli. While not all of the meningitis was caused by the bovine type of bacillus, due weight was given to this organism as an important factor.

Holm says that in those parts of Denmark where tuberculosis among cattle has been highly prevalent, nearly half of the cases of pulmonary tuberculosis in farmers have been shown to be produced by the bovine type of tubercle bacillus. He says further that most likely tuberculosis among cattle has been responsible for the fact that in some parts of Denmark the tuberculosis morbidity and mortality were greater in the rural districts than in the towns. Among 11,072 persons with pulmonary tuberculosis who were alive on January 1, 1944, cultivation only of tubercle bacilli revealed that about 3.5 percent had the bovine type. Among 139 patients of 70 years or over, 6.5 percent revealed this type of bacillus. From actual typings made in the State Serum Institute in Copenhagen since 1932, among 18,231 cases of pulmonary tuberculosis, bovine organisms were found in 4.1 percent, whereas, among 4,186 cases of extrapulmonary disease the bovine type of bacillus was recovered in 19.8 percent. In this group the highest percentage, 34.2, was among those with cervical lymph node tuberculosis.

The bovine type of tubercle bacillus on invading the tissues of previously uninfected persons produces the primary type of tuberculosis which results in sensitization of the tissues to tuberculin. Therefore, when living bovine type of tubercle bacilli are present in the dairy products consumed by humans one finds a high incidence of tuberculin reactors among the children and young adults. As tuberculosis was controlled among the cattle herds county by county throughout the United States, there followed a sharp decline in the incidence of tuberculin reactors among children born after the veterinarians' program became effective. Smith has shown that such a decline in the death rate and morbidity rate of extrathoracic tuberculosis also occurred. In fact, in 1917 when the national eradication campaign began, the death rate from such forms of tuberculosis was 22.5 per 100,000, whereas, in 1942 it was only 3.5, a decrease of 84 percent.
seems most probable that the allergy produced in human tissues by the bovine type of tubercle bacillus set the stage for a great deal of pulmonary tuberculosis when such allergic persons became infected with the human type of organism. Doubtless a good many persons also developed chronic pulmonary tuberculosis from the bovine organism. As the disease was controlled in the cattle herds there also followed a definite decrease of pulmonary tuberculosis in man from a death rate of 124.6 in 1917 to 39.6 in 1942, a decrease of 68 percent. In 1942 Beattie et al were unable to find the bovine type of tubercle bacillus in the sputum of 366 tuberculous patients in hospitals and sanatoriums scattered throughout the State of California. Thus, the control of tuberculosis in cattle, although not responsible for all of the decrease of the disease in man, has at the same time played a tremendous role.

In 1940 I was desirous of finding a phrase that would describe the accomplishments of the veterinarians and their allies in controlling tuberculosis among humans and cattle. After conferring with several associates and considering a large number of phrases we decided upon "Man's Greatest Victory Over Tuberculosis". In all of the history of animal and human medicine there is no such accomplishment to be found in tuberculosis control.

The present tuberculosis situation among the cattle of the United States is the best in the world. The entire nation and all of its possessions enjoy the modified accredited rating. However this permits up to one half of one percent tuberculin reactors among the cattle herds on any given testing. The actual testing of 8,454,453 cattle throughout the nation during the fiscal year ending June, 1946 revealed 0.23 percent reactors. Large areas now exist in which there are no reactors among the cattle which apparently means complete eradication. There are other areas in which the disease has not been eradicated. Thus at the present moment your goal has not been quite attained.

Among humans in the United States the morbidity and the mortality from tuberculosis are lower than they have ever been since records have been preserved. Between 1919 and 1921, among the deaths from all causes 6.9 percent of those of the white, and 9.1 percent of the non-white population were caused by tuberculosis, whereas in 1939–1941 only 3.8 percent among the white and 5.9 percent of the non-white population deaths were due to this disease. However, morbidity and mortality do not constitute our best criteria as to the effectiveness of a tuberculosis control program. This is because illness and death from tuberculosis for the most part occur years and even decades after the original invasions of tubercle bacilli. Our only good criterion of the effectiveness of control measures is the incidence of tuberculin reactors among children and young adults born since the control program was instituted. Here excellent progress has been made. The testing of college and university students in various parts of the nation during the school year 1932–33 revealed that 35 percent had primary tuberculosis, whereas during the school year 1942–43 only 18.6 percent. That year there were 13 colleges which reported that less than 10 percent of their students reacted to tuberculin.
Among high school students there has also been a sharp decline in the incidence of primary tuberculosis (tuberculous infection). From 1934 to 1946 this decreased among Chicago high school students from 33 to 21 percent. During the same period in Syracuse, New York it decreased from 34.7 to 6.2 percent. In rural Kansas only about 3 percent of high school students have primary tuberculosis. From the available data throughout the country it appears that only about 12 to 15 per cent of high school students are infected with tubercle bacilli.

Among children under high school age, primary tuberculosis (tuberculous infection) is rapidly decreasing. In one city of approximately 500,000 population, 47.3 percent of the grade school children had this disease in 1926. However in the same schools in 1944 only 7.7 percent were infected. Among those children of six years only 2 percent reacted to tuberculin which indicates an annual infection attack rate of one third of one percent. The tuberculin testing of 12,000 school children in 1945 in rural Minnesota by Jordan revealed only 2.7 percent reactors. Indeed, in 153 of the schools of this area not a single child reacted to tuberculin. This indicates complete eradication of tuberculosis among humans at this age level. From available data it now appears that not more than 10 percent of the children under high school age of this country have primary tuberculosis (tuberculous infection). It is my opinion that the rapid decline of primary tuberculosis among children and young adults of this country has resulted more from the control of bovine tuberculosis than any other factor.

THE FUTURE

What the future holds for any project is always uncertain. Circumstances could arise which would seriously retard the tuberculosis eradication program. On the other hand, events may develop which will markedly hasten it. To attain the ultimate goal the veterinarians have some difficult hurdles but they are not insurmountable. Despite the well established fact that the bovine type of tubercle bacillus is highly pathogenic for human tissues we are still confronted with the occasional person who contends that a great injustice has been done man wherever tuberculosis has been controlled among the cattle. An article published by Rainey in 1945 is capable of markedly retarding the completion of your eradication program should it be widely circulated among uninformed persons. He says: "Finally, the writer would summarize or define his thesis as, in effect, a plea for the abandonment of the test-and-slaughter policy for the control of tuberculosis or any other common disease of mammals on the grounds that it is in conflict with the nature of things, and consequently must fail in the end." Holm recently wrote: "As long as tuberculosis among cattle prevailed in Denmark, the tubercle bacilli present in milk effectuated a vaccination against tuberculosis in the inhabitants, even though this was not intended. Now, however, after tuberculosis among cattle has been practically eradicated in great parts of Denmark, the vaccination previously obtained from milk has been replaced by the more rational BCG vaccination." It would seem far more rational if Holm would seek the sources of infection of the remaining tuberculin reactors and control their disease than to sensitize the tissues of all persons with BCG, thus completely nullifying the tuberculin test, which is man's best diagnostic and epidemiological agent. Moreover,
it is difficult to understand Holm's reasoning when, in the same article, he states that nearly 20 percent of the extrathoracic, and 4 percent of the pulmonary lesions in humans are caused by the bovine type of bacillus. Why did not the immunity he ascribes to this organism operate in this group?

The no-visible-lesion reactor will probably continue to be used as evidence against the eradication program despite your logical explanations. Infections with avian and human types of bacilli and probably acid-fast soil bacilli will continue for a while to cause some difficulty. However, failure to find lesions when reactions are due to the bovine type of bacilli simply means that diagnoses are made so early that gross lesions are not yet in evidence. This is a highly desirable situation. Frequent emphasis of the fact that lesions are always present in tuberculin reactions, although some are too small to be detected, will be necessary to overcome the opposition. The significance of the tuberculin reaction in humans has been challenged because lesions often cannot be visualized in the chests of reactors by such a crude procedure as X-ray inspection.

CATTLE GET TUBERCULOSIS FROM PEOPLE.

Apparently one of your difficult problems in the near future is that of cattle becoming infected from humans who have contagious tuberculosis. There is still a considerable number of persons apparently well or only slightly incapacitated who have contagious tuberculosis, not all of whom are aware of the presence of the disease. When they come in contact with cattle in any capacity they constitute a serious menace to your program. Probably the majority of them are eliminating the human type of tubercle bacillus, but it is possible that some of them have the bovine type of tuberculosis. This is particularly true of older individuals in whom there may still be considerable residual disease caused by the bovine type of organism. Feldman has shown that while the human type of tubercle bacillus does not often produce serious disease in cattle, it does result in lesions which cause the animals to react to tuberculin. Apparently no evidence has been adduced to show that the human type of tubercle bacillus is transmitted from one animal to another. Tice reported the case of a man with pulmonary tuberculosis who infected four herds of cattle over a period of two and one half years. This man had the bovine type of disease which was believed to have been contracted from his original herd after which he transmitted the bacilli to his next four herds.

Preemployment and periodic examinations thereafter are now being required in many places such as industries and schools where large numbers of persons are assembled. It would be of tremendous advantage to cattle owners if every person who comes in contact with the animals were required to be examined periodically for tuberculosis. This should apply to farm hands, the owners, the members of their families and all others in any way associated with cattle. The entire tuberculosis control movement would be definitely advanced if a bulletin stating facts and urging this procedure were issued and widely circulated among persons engaged in the cattle industry throughout the nation. I know of nothing at this time that would be more productive than such a project instituted and maintained by this organization or any of its members.
Probably the greatest danger of retardation of your eradication program lies in a sense of false security which may already have developed in the minds of some persons. Doubtless there are those who believe that since 99.77 percent of the cattle of the United States are now free from tuberculosis, very little effort is necessary to complete the work. Others may be of the opinion that no effort is necessary, as the disease may completely die out in the 0.23 percent of the animals that now have it or that from such a small percentage it could never rise again to significant proportions. Such thinking and expressions are dangerous. It is certain that among the 0.23 percent of infected animals there are those which would develop contagious tuberculosis if they were left in the herds. Thus tubercle bacilli could be spread to large numbers in a short time. We must be reminded of the statement made so frequently in the past by such workers as Mohler, Kiernan and Wight, to the effect that as long as there is a single tuberculin reactor among the cattle of the United States there is a tuberculosis problem.

The glamour of 20 years ago has gone. Some will feel that far too much work is involved to justify the finding of only the occasional tuberculin reactor—2 per 1000 tested. One veterinarian told me that to find a reactor is almost like hunting for a needle in a haystack. Therefore it may be necessary to devise special means to keep the goal brilliantly illuminated so it will be constantly in view of all the workers.

A great deal that is being done to control tuberculosis among humans was learned from the veterinarians. We have not been able to keep pace with you but are trailing by about 40 years. For this tardiness there are some legitimate reasons; one is the long span of human life, during which the infected must be kept under observation. Another is the high percentage of infected persons when our campaign began. Illegitimate reasons for our tardiness consist mostly of bickering over such subjects as the meaning of a tuberculin reaction, the existence of a dividing line between infection and disease, and whether it is an asset to be infected with tubercle bacilli. On several occasions our work has been slackened by waves of unjustified enthusiasm for immunizing agents. Despite the fact that adequate proof of the efficacy of any such agent has not been forthcoming, statements have been made in newspapers and popular magazines which lead the public to feel that at last it is possible to take a shot of "something" and forever be protected against tuberculosis. Therefore they see no reason to continue to put forth effort to control the disease in their communities. At this moment there is a dangerous attitude being developed among our people with reference to BCG. Although its efficaciousness has never been satisfactorily proved, sizable segments of the population have been convinced that this alone will control tuberculosis.

Despite these handicaps and retarding factors, much progress has been made by the same general method you have employed in eradicating tuberculosis from cattle. We test with the same kind of tuberculin and thus find those with lesions in the same manner as you do. While you put an end to the disease at this point by sacrificing the animal, we must proceed to the various phases of the examination to determine whether clinical disease is present. If not found, we must watch the reactor through periodic examinations. If clinical disease is found on the initial examination or subsequently, methods of treatment are available which will
BOVINE TUBERCULOSIS

prevent many cases from becoming contagious or even ill. When contagion or illness or both are found isolation can be practiced in hospitals and sanatoriums where only patients, personnel, and visitors are exposed to the disease. Recently strict contagious disease technique in such institutions has been found extremely effective in the protection of these persons.

All of this is costly. In fact, over each two-year period we spend almost as much as was required to bring about the modified accredited rating for bovine tuberculosis in the entire nation. To operate our sanatoriums alone costs us over $100,000,000 annually. However, this cost should rapidly decrease because such a small percentage of children and young adults are now infected with tubercle bacilli, and even this percentage should rapidly be reduced. This should lead to a corresponding reduction in morbidity, so that large numbers of sanatorium beds will no longer be necessary for tuberculosis. In fact, this situation has already been realized in one state, where the 2300 sanatorium beds were in great demand a decade ago but today 500 of them are not in use because of lack of patients.

Counties are now being accredited in the United States on the basis of tuberculosis accomplishment among humans and schools are being certified according to the quality of their tuberculosis programs. These procedures are exceedingly effective in stimulating interest and producing results. This is just another of the many methods we learned from the veterinarians.

It would be a terrible catastrophe to the veterinary profession and its allies if anything should occur to prevent the attainment of the goal toward which you have worked since 1917—complete eradication. The interested public of this country is fully expecting you to announce that the disease has been completely eradicated at a time not too far distant, just as you announced in 1940 that the entire nation was designated as a modified accredited area. Many of the workers in tuberculosis in humans are holding up your accomplishments as a goal to be attained in man. Already they are stating that you have completely eradicated the disease from the cattle of vast areas of the United States and that you will probably make this complete for the nation. When you accomplish that goal it will immediately become the goal of those working with humans. When we have both attained this goal we will have demonstrated the method by which tuberculosis can be eradicated throughout the world.

REFERENCES


JORDAN, L. S.: Minnesota first to take up school certification for tuberculosis control. Everybody's Health, 31: 8, 1946.


VON BEERING, E.: Extermination of tuberculosis. Extract from a lecture delivered March 16, 1904 at the Agricultural Exhibition at Bonn. No. 3.


REPORT OF COOPERATIVE TUBERCULOSIS CONTROL PROGRAM

BY E. LASH, D.V.S.


The importance of continuing the testing of herds of cattle that are apparently free from tuberculosis, has been further demonstrated. Such a precaution is necessary as shown by the fact that quite a number of supposedly clean herds have been found to be badly infected. One county was temporarily removed from the modified accredited area, but it was possible to restore it to its former status before the end of the last fiscal year, June 30, 1946.

Many counties in the United States are overdue for remodification. At the meeting of this Association in 1943, the uniform methods and rules were amended so that areas accredited with less than .2 percent infection on original test, could remain in the accredited status for 6 years if the infected herds were quarantined and retested; also that such areas could be continued for another 3 years, during the war, if all infected herds were quarantined and retested. Consequently, some areas have not had a complete test for 6 years and others for about 9 years. Although this has made it possible to continue these areas as accredited, in some cases it has created serious conditions. As soon as more veterinarians are available, it is hoped the counties overdue may be remodified and that many more complete tests of counties may be made in order to locate and eradicate any remaining centers of infection.

During the last fiscal year, a total of 8,454,463 cattle, located in 505,296 herds, were tuberculin tested, and the infection disclosed, .23 percent, was slightly lower than the previous year. About 348,000 more cattle were tested than during the previous year.

About $1,438,000.00 was expended by the Federal Government for operating expenses and indemnity during the fiscal year 1946. The combined State, territory, and county expenditure was about $3,250,000.00. The average appraisal of reactors was $174.20; average salvage, $69.00; average State indemnity, $37.27; and average Federal indemnity, $23.89. Of the reactors slaughtered, 8 percent were registered purebred cattle.

Reports received from Federal inspectors in charge of meat inspection have been valuable in locating the premises from which infected animals originated. During the last fiscal year, of 12,564,738 cattle slaughtered at federally inspected establishments, exclusive of reactors to the tuberculin test, only 4,499, or .035 percent, showed any evidence of tuberculosis; 1,058, or .008 percent, being condemned. These percentages are slightly lower than those for the fiscal year 1945.

NO-VISIBLE-LESION CASES

Since the beginning of the cooperative campaign to eradicate tuberculosis in cattle, there has been a gradual increase in the percentage of no-visible-lesion
cases, based on reactors slaughtered, although during some years there was a decrease. The percentage of no-visible-lesion cases, based on reactors slaughtered, was 7.1 percent during the fiscal year 1920 and 39.2 percent during the fiscal year 1946. On the other hand, when based on the number of cattle tested, there has been a gradual decrease in the percentage of no-lesion cases. This figure was 0.239 percent for the fiscal year 1920 and 0.091 percent for the fiscal year 1946. It is to be expected that the percentage of no-lesion cases based on reactors slaughtered will increase; in fact, this is a healthy condition and should continue until 100 percent of all reactors to the test show no lesions.

AVIAN TUBERCULOSIS, SWINE AND POULTRY

During the last fiscal year, 42,664,755 hogs were slaughtered at federally inspected establishments, and 3,264,985, or 7.65 percent, showed some evidence of tuberculosis; 10,514, or 0.024 percent, being condemned, and 8,725, or 0.02 percent, being passed for food after sterilization. The percentage of hogs showing evidence of tuberculosis was slightly larger than during the previous fiscal year. This annual waste of pork and pork products condemned for tuberculosis in most instances is due to the avian type of the disease.

The Bureau has received a number of reports from inspectors in charge of meat inspection, particularly in Ohio, covering the slaughter of sheep which showed evidence of tuberculosis on post-mortem examination. Pathological examinations, which have been made of relatively few of these specimens, have shown that the disease appears to be of the avian type. Due to the increasing numbers of such reports received, it would appear that special attention should be given to tuberculosis in sheep, in some areas.

Professor H. R. Smith, General Manager, National Live Stock Loss Prevention Board, and other employees of this Board, continue to play important roles in connection with disseminating information on methods of eradicating this disease from poultry and swine and assisting various organizations engaged in this work.

Bureau veterinarians engaged in the testing of cattle for tuberculosis in 10 States continued the educational program and survey of farm poultry flocks in an effort to locate and remove infected birds. Observations were made of 51,174 flocks, containing 8,063,715 fowls, and infection was reported in 1,509 of these flocks.

In the North Central States where the disease is most prevalent, Bureau and State veterinarians are assigned to this work full time. These men visited 4,442 farms during the year, and inspected 691,529 fowls, reporting infection on 340 farms. They also applied the tuberculin test to 226,291 fowls, of which 4,900, or 2.1 percent, reacted.

Dr. George Senior has been assigned a special supervisor of this project for this Bureau, with headquarters at Des Moines, Iowa.

JOHNE'S DISEASE

During the year, 13,195 cattle in 12 States were tested in the cooperative work with either johnin or avian tuberculin, and 150, or 1.1 percent, reacted and were condemned. Studies of this disease are being continued at the Regional Animal Disease Research Laboratory at Auburn, Alabama. Part of the testing done during the year was in connection with these studies.
In previous reports your Committee on Tuberculosis has called attention to the dangers arising from a too-complacent attitude toward this disease. In the minds of too many livestock men, tuberculosis is regarded as a thing of the past; as a bad problem that has been licked and can now be forgotten.

This group does not need to be told that this problem has not been finished; that tuberculosis in cattle has not been completely licked. It is true that a magnificent job was done during the twenties and thirties, a job that has been widely acclaimed both here and abroad. During this period, with no serious disruption of the cattle industry, with no serious shortages of dairy products, the greater part of the tuberculous animals were discovered and eliminated. Most of our herds were freed from this disease and have remained free since that time. But the disease has not been eradicated, and that was, and is, our goal. So long as even a few infected animals remain, a menace exists which could, within a few years, put us back where we started in 1917.

The necessity of retesting accredited herds periodically has been appreciated from the beginning. This will have to be done in order to hold the ground that we have gained, and to protect the enormous investment that we have made, until we are sure that the disease has been eliminated from the continent. When we had a good deal of the disease this was done annually or at least every three years. Such retests were required for owners to hold the certificates of accreditation. When large areas were found to be free, or were freed of tuberculosis, the required retests were permitted to be more widely spaced—to six years. During the war, with its shortage of veterinarians, shortage of tires and gasoline, shortage of help on the farms, many areas could not be retested as often as they should have been. This brought on the method of retesting which might be called the sampling method, a method in which the retests were conducted on only a portion of the herds in the area. Generally problem herds were included in such samples, also herds that had had infection in them most recently, and some others. Unfortunately this method of testing often gave repeated tests at reasonable intervals to some herds and left others untested for long periods of time. How many herds are in the United States today that have not been tested with tuberculin for a decade, we do not know. We know that there are some, however, and we suspect that there are many. We have heard of breaks in herds that had not been tested for more than ten years, the breaks being discovered only because the milk from them was diverted to new markets which required a test before they were accepted.

Both State and Federal governments should make every effort to see that, as rapidly as possible, these conditions are corrected. If partial or sample testing
is done in the dairy sections of the country, the samples should be so selected as to make certain that all herds will be subjected to retests at more reasonable intervals.

Even where testing has been done with sufficient frequency, some severe breaks are occurring. These breaks deserve careful study. Special efforts should be made in all such cases to determine, if possible, the source of the infection. We know that in some cases old tuberculous cows have not been picked up by the tuberculin test. We know that a few herds receive their infection from their owners; that progressive tuberculosis caused by the bovine type tubercle bacillus may come from human attendants. There may be other sources about which we do not know.

Careless work by veterinarians sometimes enters this picture. Routine testing of any kind becomes monotonous. The monotony becomes far greater when the results are nearly always the same. A fisherman qualifies for a real disciple of Isaac Walton when he can fish all day without a bite and still keep awake. It is stimulating to occasionally find the thing for which you are looking. Thousands of negative tests dull the enthusiasm of the operator. He expects negative results and he gradually ceases to be alert for indications of infection. He is inclined to grow careless in his application of the test. He is apt to think it not worth while to wait while the farmer tries to round up a few cows that are hard to get into the stable. Worse yet, he may not make any great effort to get back to read the tests when he should, and sometimes, it has been reported, he does not get back at all. He reasons, "What's the use? They will be clean anyway." and fixes up the charts accordingly.

We do not wish to be misunderstood. We are not inferring that most tests are conducted carelessly, or fraudulantly. We are convinced that most of it is well done, and that breaks often are in no way the fault of the man who has been applying the tests to the herd. We know, however, that some have not been meeting their responsibilities as they should. Such conduct, when detected, should lead to withdrawal of the licenses of the culprits.

In fairness to all concerned, we are obliged to say that we feel that some officials charged with the administration of the accredited herd plan are also culpable in placing remodification of areas on a more important basis than actual reduction of tuberculosis. We have been reliably informed that instances have occurred in which testing has been ordered in areas where the incidence of the disease was known to be low rather than in others where it was believed to be higher, in order that remodification would not be endangered. With the N.V.L. problems and the constant drive to keep counties and states within the modification limits, the conscientious field veterinarian faces serious problems.

Complaints have come to the Committee from some of the range states, that certain other states where cattle are sent as feeders, are not accepting such animals even though they originate in accredited herds, unless they have been tested within the year prior to shipment. This requirement for feeder cattle, originating in areas where it is known that the incidence of tuberculosis is very low, seems to your Committee as unnecessary and we recommend that states having such requirements consider modifying them.
There have been recent complaints from some of the northeastern states that cattle imported from eastern Canada have carried tubercle infection into their herds. The complaint has been made that B. A. I. Order 379, which has to do with health regulations of imported livestock, is too lenient. This committee assumes that no one wishes that health regulations applying to traffic in cattle between Canada and the United States should be any more drastic than those which apply to similar animals passing from one state to another, but on the other hand there is no justification for any more leniency.

At the present time the whole of the United States is modified accredited territory but this cannot be said of Canada. The Canadian government is proceeding with a plan which is nearly identical with the Accredited Herd Plan of the United States but it has not yet been extended to all parts of the Dominion. We see no reason why cattle should not be shipped from accredited herds and from modified accredited areas of Canada into the United States under rules that are identical with those which apply to traffic between states, providing the rules and interpretations in the two countries are the same. So far as we have been able to learn, the rules are the same with two exceptions:

a. In the Canadian regulations the type of tuberculin that must be used is not specified. Since January of this year, the Canadian government has been using the same type of tuberculin that we use, hence there seems to be no basis for objections on this score.

b. In the Canadian rules there is no provision for the quarantine of herds in which reactors have been disclosed when the herds are located in accredited or restricted areas. This seems to be a weakness that should be corrected.

B. A. I. Order 379 permits cattle from Canadian accredited herds to come into the United States providing it is certified that the herd of origin has been tested and found free of infection within one year of the time of importation. Cattle originating in accredited areas are admitted freely but the certificate must show that the herd of origin has a fully accredited status.

Since we have no counterpart in the United States of cattle which originate in non-restricted and non-accredited areas we can make no practical comparisons, but can merely judge the adequacy of our regulations for protecting our livestock. Order 379 requires that cattle originating in restricted areas in Canada, other than range stock, shall be accompanied by certificates indicating that “in addition to the negative tuberculin test within 30 days, that all cattle in the herd or herds from which the animals proceed have been tuberculin tested with negative results within the previous 12 months.” Apparently this will permit importation of individuals from once-tested, free herds so long as the individual passes a test administered within 30 days. If the entire herd has passed one test within 30 days it would appear that any or all members would be eligible for importation into the United States.

The same order requires that to be eligible for importation into the United States all cattle, except strictly range stock or those from fully accredited herds, originating in non-restricted areas of Canada, must be accompanied by certificates indicating that they come from herds of which all members have passed a tuberculin test administered within 30 days of the date of importation. This places them on
the same basis as the group mentioned above, i.e. they must come from once-tested, free herds.

In the earlier days of tuberculosis eradication in the United States when we had many infected herds, untested herds, once-tested free herds, as well as accredited herds, the principle involved in allowing traffic in cattle was that free exchange could be permitted between herds of equal status but restrictions were placed on the shifting of individual animals from herds on a lower status to those on a higher one, so far as tuberculosis was concerned. This was a logical procedure which Order 379 does not fully protect. Since cattle imported from Canada into the United States will go, for the most part at least, into fully accredited herds, it does not seem logical to permit once-tested free animals to enjoy this privilege, and we recommend that the order be modified to correct this discrepancy.

Your committee wishes to make it clear that it has no information which indicates or even suggests that the weakness indicated in Order 379 has been responsible for the alleged troubles. We recognize that much of the traffic goes through the hands of cattle dealers and we know that these are not always honorable and trustworthy. We suspect that irregularities which regulations cannot fully correct have played a more important role, than weakness in the regulations. This is not an argument, however, for allowing weaknesses in regulations to remain, once they have been recognized.

This committee has repeatedly called attention to the fact that we need tests other than tuberculin, or perhaps a better tuberculin, to complete the job of eradicating tuberculosis from our cattle. Although the tuberculin test is as accurate as any biological test of which we know, it has some shortcomings. The shortcomings of the test have long been known but they were not particularly serious so long as we had a considerable amount of tuberculosis to deal with. Now the incidence of the disease is very low throughout the country, the N.V.L. (No Visible Lesion) cases are a cause of real concern. It is now quite certain that most of these cases are not affected with tuberculosis but are sensitized in unknown ways. We are destroying annually a significant number of animals, and we are at the same time stigmatizing a considerable number of herds, because of these failures of the tests. Some work on these problems is going on in California and New York and some is being done by the Federal government at Beltsville, but a great deal more should be done.

The finding of tuberculous herds through the tracing of diseased animals discovered in the slaughter houses of the country has contributed substantially to the solving of the tuberculosis problem. This method should be perfected in the establishments where Federal inspection is maintained, and it should be used as fully as possible in the local slaughter houses under State and municipal inspection.
THE DIAGNOSIS AND CONTROL OF CATTLE MANGE
AND SCABIES

BY DONALD W. BAKER, D.V.M.

Ithaca, New York

The topics discussed this afternoon have been matters of national interest. During the past two days I have had occasion to inquire of men who have knowledge of conditions throughout the United States, and it would seem that the subject which I am to talk about this afternoon is a more local problem. From the information I have gathered it would seem that the infectious parasitic dermatitis of cattle, which the farmer in his way calls barnyard itch, is a problem pretty much of New York State, the veterinarians and the farmers living there.

The various specific infections of the skin of cattle which the farmer commonly calls barnyard itch were discussed at a meeting of the American Veterinary Medical Association this summer. I had thought that would be sufficient at least for one year, but I have been asked to speak about it at this meeting, and I was very glad to attend and try to give you the information which we have secured from a study during the past twelve or eighteen months.

Since the principal disease involved, sarcoptic mange, is listed as a reportable disease by both the federal and state agencies, I feel much better at this moment, because Dr. Howe, who is the Chief of the Bureau of Animal Industry of New York State, and Dr. Simms are here and can answer your questions.

Most of my time will be taken up with illustrations of the conditions which we find in New York. However, before that I wish to point out the importance to practicing veterinarians, to county veterinarians and to any official veterinarians who have any dealings with farmers in the control of these conditions, that it is very important to make the necessary differential diagnoses. From our studies during the past year we have found that the most common parasitic infection is lousiness in New York State. This may also be the least serious of these infections.

Most of you have seen the lice that are found on cattle, but maybe you haven’t seen all of them that we find in New York State. We have three kinds of sucking lice with which you are familiar: The short-nosed sucking louse known as the haematopinus eurysternus; the long-nosed sucking louse known as the linognathus vituli, and within the past few years a new invader of our Empire State, which I will show you in a few minutes. We also have the common biting louse.

In addition to lousiness we have other miscellaneous infections which I shall speak of before we discuss cattle mange. One of the most serious of these miscellaneous infection is a fungus infection known as ringworm. The best informed authority on this subject is also in the room, and he can answer any of your questions with respect to the diagnosis and control of that disease. Ringworm is very often mistaken for sarcoptic mange, as I will show you in one of the slides.

Another infection which we are seeing more commonly in New York State is a worm infection of the skin. The disease is known as stephanofilariasis. It is a
CATTLE MANGE AND SCABIES

member of the group known as filaria worms, living in the skin, and since we find the microfilaria present in scrapings I think it can properly be called an infection. This disease is being found quite commonly in animals brought into New York State, and we have pretty good proof that at the present time there are at least a few cases of animals which were born and have been raised in New York State which are infected.

Other miscellaneous infections in which the etiology is either unknown or which we don't feel competent to discuss are frequently encountered. During the summer we have seen some very interesting cases of photosensitization. I will show you two pictures of that condition. More recently, and talking to practicing veterinarians during the past two months, I find that there is a very interesting type of dermatitis which is probably not infectious but which is causing considerable interest on the part of the farmers, in young calves fed on the so-called calf starter meal. They develop a very scurvy skin which probably should be called eczema, but which veterinarians are very apt to mistake for sarcoptic mange. This condition, incidentally, is very easily cured, if we can use that term, by removing the offending part of the diet and substituting milk. The animal usually recovers very quickly.

These slides will show you some of the etiological agents and conditions.

(Slide) This is very common. You will recognize these parasites as sucking lice. This was made from a scraping of the skin of an animal. Frequently cattle become so heavily parasitized or infected with lice, at least in New York State, that they suffer rather severe consequences. Debilitation, anemia particularly from the sucking lice. These, of course, are usually bulls and young stock, animals that are not taken care of personally by the owner during the long winter months.

(Slide) This shows you one of the nits or louse eggs with larvae inside. We have been trying some new insecticides to determine whether we have anything that might kill the embryo within the egg.

(Slide) These are pictures taken three or four years ago. A graduate student at Cornell made a study of cattle lice. In writing his report he was able to secure enough funds to illustrate the bulletin rather nicely, and these are paintings of the lice. You will recognize this as the short-nosed sucking louse, the Haematopinus eurysternus.

(Slide) This is the long-nosed sucking louse which is a little smaller than the other one.

(Slide) This is the smallest of the three, the little red louse or biting louse of the cow. It is quite common.

(Slide) These are the ones I spoke of a while ago as the invaders known as the Solenopotes capillatus, very common now, probably out-numbering the long-nosed and short-nosed lice.

(Slide) Those of you who frequent slaughter houses or who have an opportunity to examine steers or feeder cattle will probably recognize these lesions, which appear usually on the abdomen. Sometimes they are on other parts of the body. This is one of what I would call an active lesion of stephanofilariasis. Scrapings made from the raw surface or sections of the skin will show evidence of the worms.

(Slide) This is another lesion. These are the only two I will show. I have
quite a lot of slides showing what we might call inactive lesions. This is just skin without any hair on it.

(Slide) This photo micrograph of rather high magnification shows a section of the worm with larvae.

(Slide) This is one of the puzzling cases which we meet occasionally. This cow was diagnosed, from a casual examination by the veterinarian, as a case of sarcoptic mange. I think the picture was taken in April, because I see a little sign of snow on the ground. There is another picture which shows a better view of the disease.

(Slide) Examination of scrapings from various parts of this cow’s body on the skin showed no evidence of any type of mange mite or scab mite, and these scrapings were positive when examined for evidence of fungus. We found this to be a good case of ringworm, although not a typical case.

(Slide) We have a couple of slides to show the picture of photosensitization. This is a picture made about two weeks after the animal had been admitted to the clinic.

(Slide) This shows the skin of the animal, very dry. It felt just like paper. It was removed and the animal recovered, but you can see what a large portion of skin was lost. An interesting thing in connection with this type of skin trouble is that only the white part of the skin was affected. The dark areas were never affected.

(Slide) This is the picture as she came into the clinic.

(Slide) These are pictures to show some of the common lesions of sarcoptic mange in the cow. This is a very commonplace lesion in dairy cattle in the herds in New York State.

(Slide) This is another site for the infection, on the legs and above the udder in the region of the escutcheon.

(Slide) Also down here, near the extremities of the legs, it is quite common.

(Slide) In many herds we find that the face and mouth and muzzle usually show evidence. The reason I am showing you this is that I wish to speak a little later of our methods of treatment.

(Slide) The scraping of the skin with any object such as a small stick, any blunt object, usually in the case of mange can draw blood and you can get good scrapings with such an object; you don’t need a sharp knife.

(Slide) This is an interesting aspect of bovine sarcoptic mange as we found it in New York State. As the reports came in last winter we heard from several sources that the original diagnosis was made by the family physician. The child may have contracted a peculiar skin infection. Sometimes the wife, the man who owned and milked the cows, and quite frequently the hired man were affected. In fact, it became a source of considerable labor trouble in the State. I don’t think I am exaggerating too much.

This picture shows a man’s back. Some of you may have attended our annual conference at Ithaca last year in January. If you did you probably saw this man. We asked one of the veterinarians to bring a good case of sarcoptic mange to the College in order to demonstrate it to the people who were interested, and the hired man came along. The hired man told me (I didn’t know it before) that he had the
disease, too. He said it had been impossible to get more than two hours' sleep at night for the last week, and that he expected to resign or quit his position rather shortly, but he was interested in attending our meeting first. So I asked him if he would care to demonstrate his condition. Before the 350 or 400 spectators he came up on the platform and removed his shirt. He showed us the condition.

This is quite typical. Traveling about the State and examining herds, we have found that quite often some member, and usually more than one member, of the family suffered from sarcoptic mange. This is a rather extensive case.

(Slide) Scrapings made from the skin usually are easily obtained. We ask the affected individual to scrape a portion of his forearm and we demonstrate the mite in several cases that way.

(Slide) In the course of the campaign which was carried out during the year, in which the county veterinarian with the county agent would find some cooperative farmer, we would invite the people who were interested in the disease and its control to go to the farm, make the necessary microscopic examinations to establish a diagnosis, carry out the methods which we thought would provide the best effective treatment, and in several cases I encountered these human contact cases were handled that way.

This boy came back from school, and his father said he had had some trouble with his cheek. We made the examination of the case.

(Slide) The control of bovine sarcoptic mange in New York State presented many difficulties. Those of you from the South and the West know that the most effective practice in those regions would be to dip all animals in infected or suspect herds. The disease developed during the winter last year, and bovine sarcoptic mange is a seasonal disease, as you know. It usually appears about this time of the year, and continues until late March or April.

In New York State we were unable to find a dipping vat anywhere. I think there were two in rather poor repair at railroad terminals. We found no dipping vats that could be used, so we had to try something else. At the suggestion of some of the state officials we secured the cooperation of the county disinfectors. They are men who go about the county and apply the disinfectants and whitewash to the barns. These men are very much interested in this particular procedure. They are usually equipped with a truck and a pumping arrangement, a tank which will hold several hundred gallons, at least 100 and sometimes 200 or 300 gallons. They can develop 200 or 300 pounds pressure.

(Slide) They are usually equipped with a heater so they can heat the material which is to be used to any temperature they wish. We usually heated it to at least 100 to 110 degrees. It was applied to the cow using a special nozzle arrangement.

(Slide) Before I go into that too far I will mention this case. In addition to the mange which is caused by the sarcoptic mite, the scabies produced by the chorioptic and psoroptic mites, we found some animals affected with the demodectic mite, a demodectic mange. Unfortunately I don't have a colored picture, but there are some pictures in the pamphlet I have which illustrate the disease.

When the exudate of these little round lesions is expressed and examined grossly, it looks about like what you see here. Of course this is magnified considerably
on account of the projection. The material is waxy in consistency. It usually is blood tinged and it will float in water. It is very difficult to make a preparation by mixing it with water, so usually we just spread it out on a slide and put a cover slip or another slide on top of it and make our examination. This material is almost a pure mass of mange mites. There is hardly a pus cell or any other extraneous material. Literally billions of these small cigar-shaped demodectic mites are present.

(Slide) I loaned my slides showing the sarcoptic and psoroptic and chorioptic and demodectic mites, but I happened to have this one left, which most of you will recognize as the male of the chorioptic scab mite.

The diagnosis of sarcoptic mange in New York State, we found, was hampered by the fact that very frequently the practicing veterinarian did not come in contact with the infected herds. Sarcoptic mange, like most of our bovine diseases, is no respecter of man or of economic status or anything of that sort. However, many of the aggravated cases were found in rather small herds, and the owners as a rule seldom called the veterinarian. Many of these bad cases were reported to us by veterinarians or health officials who had been asked to visit the farm by the milk companies. The milk supply had been shut off.

This disease is rather peculiar in several respects. One is that the owner of the animals and sometimes the veterinarian who makes the casual examination does not fully appreciate the economic loss sustained by the owner who has a mangy herd of cattle. The animals develop the disease, which is chronic in nature, rather slowly, and the farmer, seeing his cows every day, notices very little change in them.

As the disease progresses and the animal spends most of its time licking itself or moving itself about trying to relieve the extreme itchiness, he will notice that something is wrong. He does not notice the gradual loss in milk production. Invariably last winter the owner became a very enthusiastic supporter of any type of control program we might suggest.

I might cite one case: A herd owned by a rather well-to-do farmer in central New York had forty milking cows. He had introduced the infection into his herd through the purchase of animals at a sale. At the time we saw the herd, practically all of the forty cows were extensively infected all over their bodies, and they spent most of the time licking themselves, moving about in the stanchions, stepping around as you know they do when they are uneasy; and incidentally, in several cases this winter we found there was a considerable loss in injured animals. The animals resting on the floor would be stepped on by the cows next to them, who were trying to get over to the wall and relieve the condition on their lesions. In one small herd of only fifteen cows, six had been removed on account of injured udders and teats.

In this particular case I mention, the treatment was given on a Thursday afternoon. We returned the next Saturday and the owner told us that without adding any animals to the herd the milk supply had increased by two cans. We tell this story at meetings around the State, and I think many times people suspect we are exaggerating; but in all of these instances where treatment was given, the owners
were very enthusiastic. They would attend our other meetings and tell what had happened in their herds.

One difficulty experienced in the control last year was to keep up the interest until the condition had been entirely controlled. We suggested that in sarcoptic mange at least six treatments be given at not more than ten days' intervals. Quite often the owner would forget or would think it was unnecessary to continue the treatment past three applications, and as a result of that we are quite sure that mange will reappear in some of these treated herds that the owner might consider cured. In fact, we know of a few instances already this fall. In one case a cow which had been purchased for other purposes was kept in a box stall all summer. In the spring that cow had been treated six times with lime sulfur solution, and no evidence of skin trouble had appeared during the summer. About two weeks ago somebody noticed there was something wrong with the animal's skin, and a scraping was made and we found the mites. If we find this duplicated in other herds it will mean that our efforts were not entirely successful last year.

This discussion will be concluded by a four-minute presentation of a movie in color, showing some of the animals in one of the herds in which sarcoptic mange was diagnosed and treated. The owner in this case told us that he found it was impossible to turn the cows out for exercise. He had to keep them locked up for the last month or two. I suggested that he turn them out, to show me what would happen; so he turned two of them out in the barnyard, and within ten minutes they were bleeding in several places. I think this film will show you why. I might say that at the Boston meeting we had a pamphlet prepared for distribution to those who were interested. That pamphlet was prepared at the suggestion and insistence of certain groups in New York, so some information could be given to farmers, veterinarians, county agents, who were interested in the control of the disease.

The requests were so great that the supply was exhausted very early, and we had to have a new printing made. I have a few of the pamphlets here. Those of you who were unable to secure a copy in Boston, or who have not had one since, may come up and take one. We have 100 here at the rostrum, and when the film has been shown you may come up and take one.

With respect to the treatments that were given, the Bureau and the State agencies suggested the use of lime sulfur solution containing at least 2 per cent sulfide sulfur. This has been used in most cases and applied hot to the animals. However, some of you know that it is rather difficult in some places to give this without considerable objection by the owner. Some people can't stand the lime sulfur on their skin and apparently some cows find it rather serious, and it may cause increased inflammatory conditions.

During the winter we tested another mixture which consisted of sulfur which had been treated with a wetting agent.

... The motion picture was shown ...

This is one of the cows that was turned out in the barnyard. This is a very well developed case. I doubt if you could find a place on her body the size of your hand that was not infected, and from which you could not demonstrate the mites.
in scrapings. You see, just a slight scraping with a piece of wood draws the blood. Of course, the owner and any other attendant to this animal is apt to get the infection when he is milking her. If he leans against the cow and pushes his forehead into the flank of the animal or in any other way comes in contact with the cow, he is likely to catch it.

It is relieved rather easily. In the course of our work last winter, particularly when we had two or three meetings a day and didn’t have the opportunity to take hot baths, even I became infected. It caused some uneasiness for a couple of days and nights, but I applied a very effective treatment. I don’t know whether it is proper to discuss the treatment on man, but the drug is easily obtainable and quite effective. Since the ingredients are common and are sold under various trade names by quite a number of companies, I might as well tell you that we used benzil benzoate, which probably would be very effective on cattle except that it would be rather expensive.

This is the place where the farmer probably picks up the infection more commonly than anywhere else.

These cows will stand for hours and lick themselves. This is the nozzle arrangement, a 3" pipe eight feet long, and at the end is a piece about a foot in length with three nozzles tipped up so you can stand at the rear of the animal and reach up underneath her body, spray that area, and then spray about twice along each side and once over the back. We are applying more than usual on this particular animal, but by spraying as I have described, and requiring a time interval of about forty-five seconds, we can get an average of two gallons of this material to an animal. In fact, you can go down a line of fifty cows and apply 100 gallons in about forty minutes.

The treatment is much more effective if the animal is brushed with a stiff brush or comb afterwards. The skin becomes hard and encrusted with the exudate, so a brushing makes it much more effective. The most important consideration, however, is to impress the farmer with the importance of repeating this at not more than ten-day intervals, for five or six treatments.
LIVESTOCK PARASITE PROBLEMS IN THE SOUTHEAST

BY LEONARD E. SWANSON, B.Sc., D.V.M.

Parasitologist, Agricultural Experiment Station, University of Florida, Gainesville, Florida

GENERAL CONSIDERATION

The southeast, with an abundance of rain, slow run off, warm climate and a lush growth of grasses and vegetation, is ideal for parasitic life. The latitudes of the regions and the proximity to semi-tropic bodies of water give the whole area a climate favorable to parasitic infestations.

Within the last 10 to 12 years, farmers and ranchers became interested in better livestock; consequently, many of the old cotton fields have been converted into permanent pastures and thousands of acres of open ranges have been fenced. The long growing seasons with the possibility of establishing improved pastures on cheap lands have induced cattlemen from other sections of the country to move to the southeast and establish ranches. Hitherto, waste lands, such as palmetto and wooded areas, have been cleared and permanent pastures established.

Sales barns and stock yards have been established throughout the entire area. Purebred Hereford, Shorthorn, Angus and Brahman cattle have been imported from other sections of the country in large numbers and distributed over the southeast. The purebred animals are being crossed on native cattle for the most part; however, numerous purebred herds have been established.

The grazing program has been developed quite rapidly; though not in line with the increased population of cattle. This situation has resulted in an overstocking of pastures in many instances. Many stockmen do not attempt to produce supplementary feed for wintering their cattle. Overstocking, overgrazing, and the mixing of cattle of all ages are factors that are conducive to heavy parasite loads, especially when the climatic conditions are favorable for parasitism. The build-up of parasite larvae under these conditions is tremendous when we consider that one female parasite is capable of laying from 200,000 to 50,000,000 eggs daily, the heavily parasitized animal, of course, passing the greater aggregate in numbers.

Although the cattle industry is the most important livestock enterprise in most areas of the southeast, yet other classes of farm animals cannot be overlooked. Sheep and swine are very important in the northern part of this region, whereas horses and mules play a great part in the farming enterprise. Riding horses are rapidly becoming very popular both for pleasure and work. All classes of farm animals will be mentioned in this paper, but time does not permit detailed consideration of any parasite.

INTERNAL PARASITES

Bovine: These animals of all ages are subject to the ravages of nematodes, cestodes, and trematodes. It is not uncommon to find animals infested with Haemonchus spp., Ostertagia ostertagi and Trichostrongylus axei of the abomasum; hook-
worms *Bunostomum phlebotomum*; threadworms, *Cooperia spp.*; nodular worms, *Oesophagostomum radiatum*; whipworms, *Trichuris discolor*; and tapeworms *Moniezia spp.* of the intestinal tract at necropsy. In addition to the above-mentioned parasites, these animals are commonly found to be heavily infested with coccidiosis and strongyloides when fecal examinations are made. These parasites are not detected on routine post-mortem examination. In spotted areas, we occasionally find *Cysticercus bovis* in slaughter animals.

**Ovine:** Sheep like cattle are ruminants and these animals are often infested with the same species of parasites as the latter. Sheep, however, succumb to the ravages of the parasites more readily than do cattle and, therefore, the problems are more pronounced.

**Suis:** The swine industry of the southeast pay a tremendous toll in losses as a result of parasitic diseases. The most common parasites found on necropsy are: *Hyostrongylus rubidus*, *Physocophalus secalatus* and *Ascarops strongylina* of the stomach; roundworms *Ascaris suis*, hookworms *Globocephalus wosubulatus* and the thorny headed acanthocephala, *Macracanthorhynchus hirudinaceus* in the small intestine; nodular worms *Oesophagostomum spp.* and whip *Trichuris suis* in the large intestine. Coccidiosis is often encountered where whole herds are affected and economic losses are tremendous. The above parasites are responsible for the major death losses in swine, yet the most serious loss from an economical standpoint occurs as a result of kidney worms, *Stephanurus dentatus*. This parasite found in the kidney, liver, and loin muscles is cause for condemnation of these parts at slaughter, which results in great economic loss annually.

**Equine:** The horses and mules of this region have an abundance of *Strongylus spp.*, *Spiruridae spp.* and pinworms (*Oxyuridae equi*). Tapeworms and ascarids are occasionally found, but not of common occurrence. Tapeworms may infest older animals, while ascarids may be found in colts.

**Liver fluke** (*Fasciola hepatica*) disease of cattle is confined to certain local areas along practically all of the Gulf states. In Florida, flukes are found along the St. John’s river flats, the Kissimmee river and around Lake Okeechobee. In spite of numerous swamps, water holes, ponds and lakes, flukes are not a serious pest in the southeast, except in certain sections of Florida and Southern Louisiana. No reports of fluke disease of sheep have been received. Some herds of cattle in Florida are very heavily infested with flukes. Flowing artesian wells of sulphur water serve as a reservoir for fluke snails, and comprise the principal endemic areas of infestation. Strangely enough, water holes and cypress ponds do not harbour fluke snails.

**CONTROL OF INTERNAL PARASITES**

Preventive measures are more effective, in most cases, than the actual medication of infested animals, since in many animals the damage is done by the time treatment is undertaken. Through good management practices, many parasites can be controlled. These practices include the providing of good, nutritious feed and minerals; preventing overstocking of pastures; keeping the younger animals separate from the older ones; and practicing pasture rotation. Recent experiments have shown that a given pasture must be free of cattle or sheep for at least six months if a heavily infested pasture is to be freed of parasites. This practice is not readily acceptable by cattlemen and farmers. Rotation of pastures for shorter
periods will supply more feed and reduce the parasites population, but will not control parasites. Close grazing is conducive to heavy loads of parasites and should be avoided. Tall growing grasses are less apt to carry parasite larvae. General sanitation in the livestock program is essential and effective in parasite control.

TREATMENT

Phenothiazine is not a panacea in destroying parasites, but to date is the most efficacious chemical employed as an anthelmintic for cattle and sheep. This drug when properly given in minimum, effective doses will remove most of the parasites harboured by these classes of animals. Time does not permit giving dosage tables for the various animals, but it may be stated that the dosage and method of application is determined according to the age, size and general condition of the animals to be treated. In large range herds where it is impractical to individually treat animals, medication may best be accomplished by mixing it with salt or feeds. These various methods of using phenothiazine are being investigated at this time in Florida.

Phenothiazine is safe and effective in horses, mules and swine, if properly administered; however, if improperly used with these animals losses may occur.

Hexachlorethane in doses of 10 grams per 100 pounds live weight is effective in removing adult flukes from the livers of cattle. This drug has received considerable attention since 1936 when the writer first used the compound in the form of Distal, a proprietary drug manufactured in Hungary.

DESTRUCTION OF INTERMEDIATE HOSTS

The destruction of intermediate hosts is desirable when the life cycle is known to require these various forms of life to complete their propagation. Insect intermediate hosts may be controlled by sanitation and sprays such as DDT and/or Rotenone. The classical example of this method of control is found in the liver fluke, which requires the fresh water snail to complete its cycle. Destroy these snails by drainage or filling in water holes, swamps and low lands. Copper sulphate, in weak dilutions, is extremely effective in destroying snails, and at the same time, is a necessary element to the grasses and livestock. Experiments are in progress at this time in which 20 pounds to the acre of this compound are broadcast over marshy areas by hand or from an airplane. Applications are repeated in 21 days, as the chemical is not effective in destroying snail eggs. Afterwards, applications are repeated as often as the snails reappear. Twenty-four pounds per second foot flow of water is applied to streams, taking precautions to saturate the wet banks with the chemical. In using copper sulphate, care must be taken not to apply it to fish streams, as it is extremely toxic to game fish in these dilutions. In this strength, copper sulphate is not toxic to cattle or other livestock, and is actually beneficial in mineral deficient areas.

EXTERNAL PARASITES

As with internal parasites, the southeast states have climatic conditions and other environmental factors conducive to the propagation of external parasites. Only a few of these parasites will be mentioned in this paper.
These insects are a serious pest to livestock: among these the horn fly, *Siphona irritans* (L), stable fly, *Stomoxys calcitrans* (L), and the housefly, *Musca domestica* (L), are most commonly found. The horse fly, deer fly and the Buffalo gnat are also troublesome during the summer months.

**Lice**

Cattle of this region are infested with the long-nosed louse, *Linognathus vituli* and the short-nosed louse, *Haematopinus eurysternus*. Red lice *Bovicola bovis* are commonly found. Horses, goats, sheep and swine are often found to be heavily infested with lice.

**Ox Warbles**

Until recently the ox warble was considered a parasite that infested animals in northern states; however, at this time this parasite is found as far south as Lake Okeechobee in Florida. *Hypoderma lineata* is the only grub established in the south, but with the importation of cattle from the north, *H. bovis* could possibly establish itself as has done the former. Workers must continually be on the alert for new parasites such as the South American bot, *Dermatobia hominis*, which flourishes in a climate similar to that of Florida.

**Screwworms**

The screwworm is the larvae of a diptera fly, *Cochliomyia americana*, which burrows into the broken skin. This insect presents a serious problem to the southeast in its destructive and, thus far, uncontrolled effects. In Florida the range riders use agents that are useful in repelling the fly and destroying the screwworms. Infested animals are treated insofar as they may be found, but not all cases are found and these parasites are continually propagated.

**Bots**

The horses and mules of this section are seriously infested with bots. Few cattlemen and farmers realize how heavily their animals are infested.

**EXTERNAL PARASITE TREATMENT**

**Flies:** Horn and house flies have been successfully controlled in this area by spraying cattle and other livestock with DDT water suspension containing 2.5 per cent active ingredients. Stables, barns and other buildings sprayed with DDT from 1 to 2.5 per cent suspension in water is effective in controlling flies.

**Lice:** These insects are readily controlled by dipping or spraying with DDT suspension even in much lower concentrations than used against flies. The combination of rotenone and DDT, or either alone, is effective in lice control; however, rotenone lacks the residual effects shown by DDT.

**Ox warbles:** Hand washes, dips, or sprays containing 5 per cent rotenone are effective in controlling these parasites. Hand dressing with rotenone powders may prove most desirable in the northern climates, but has not proven popular in
the southeast. Due to the difficulty in reaching the heel fly, DDT sprays have not been effective in controlling this parasite.

Screwworms: Diphenylamine in a mixture known as smear 62 is very effective as a preventive and control of screwworms. This mixture should be applied freely to all cuts and open wounds as a preventive. If the screwworms are present in the wound, this compound will kill the larvae and prevent reinestation. The big problem in the southeast in screwworm control is the open range and unwieldy large herds which prohibit close supervision. Many an animal becomes infested and is dead before found. This set-up is ideal for the propagation of these flies. Until the livestock owners can give more close supervision of their herds, the control of the screwworm will continue to be an unsurmountable problem.

Bots in horses: No known larvicide is effective in destroying the fly nits of any of the three types of horses bot flies. The only method of effective control is county and state wide, whereby all horses and mules would be treated within a given area in a manner similar to tick and tuberculosis eradication programs. Carbon disulphide given in capsules is very effective in removing these bot larvae from the stomach of these animals.

The southeast is destined to become one of the leading areas in the cattle industry, yet parasites take tremendous tolls in death loss and losses through condemnation of otherwise edible or usable products. Workers in this section of the country must strive to keep ahead of the developing livestock industry by solving the parasitic problems found in these states.
REPORT OF COMMITTEE ON PARASITIC DISEASES


SIGNIFICANT DEVELOPMENTS IN THE CONTROL OF LIVESTOCK PARASITES

Developments in livestock parasite control during the first post-war year have added a respectable chapter to the notable record of improved methods and treatments that came to fruition during, and immediately following, the emergency period. The wartime developments were summarized in the last Report of the Committee on Parasitic Diseases, and the present report is essentially a continuation thereof, in which are described the developments of the past year. These developments cover uses of DDT, benzene hexachloride, and rotenone-containing materials for the control of external parasites of cattle, sheep, and swine, as well as improved methods for controlling internal parasites by chemotherapy, management practices, sanitation, and feeding.

Regarding the uses of DDT and benzene hexachloride (gammexane, 666, hexachlorocyclohexane), one should bear in mind that we cannot yet define the specific uses for which one or the other of these new insecticides is definitely superior, nor can we describe at this time the extent to which either or both of these insecticides may replace derris and cube powders for the control of external parasites.

Control of cattle grubs on an area basis

Ever since the development of the standard derris and cube washes for the destruction of cattle grubs, there has been a keen appreciation of the importance of using the treatment on a community basis. Experimental trials of the benefits to be derived from control on an area basis, carried out on a small scale near Colorado Springs, Colorado, showed an average reduction in grub infestation of about 85 percent in the centrally located herds, and an over-all reduction of about 70 percent, the first year following systematic treatment of all infested cattle within the area. Such results indicate clearly the desirability of cooperative regional efforts to control grubs.

Recent experience in cattle louse control

Cube, derris, and other rotenone-bearing products are still widely used for cattle louse control. Workers in the Zoological Division of the U. S. Bureau of Animal Industry have dipped and sprayed many thousands of cattle in Texas, New Mexico, Colorado and elsewhere under controlled conditions, and have observed the treatment of many thousands more on farms and ranches. Good results follow the use of one pound of cube or derris, containing from 4.4 to 6.4 percent of rotenone, per 100 gallons of water in the dipping vat. No detergent is required, and the water may be used cold or warm, though a temperature of about 80°F. is preferable.
Cattle must be dipped at least twice, or oftener, at intervals of 16 days. The vat should be cleaned and recharged after heavy use, and under any circumstances a rotenone suspension is regarded as of doubtful value after standing as long as one week, particularly in an alkaline medium. Orchard spraying equipment may be used in place of the dipping vat, in which case 2 pounds of cube or derris per 100 gallons of water is recommended. A pressure of approximately 100 pounds at the nozzle is ample. About two gallons of fluid should be applied to each animal. While two or more applications of rotenone control lice quite effectively, one does not always de-louse a range herd completely in this manner because a few viable eggs appear to hatch out after the second application, thus providing the seed for reinfestation.

Thousands of cattle have been dipped in DDT, especially in the Southwest, with highly gratifying results. The use of from 0.25 percent to 0.35 percent DDT in soluble pine oil emulsions has in several instances completely eradicated mixed cattle louse infestations after a single dipping. Aqueous sprays and dips containing 0.2 percent DDT are also widely used. These appear to give good control of the short-nosed louse and chewing lice, although, in some instances, the long-nosed sucking louse has proved to be more resistant. DDT is not highly destructive of the eggs but two dippings, some 15 to 20 days apart, can be depended upon to eradicate louse infestations completely. In view of the fact, however, that one application invariably achieves such good results, a second application is not recommended as a general procedure. Sprays, in place of dips, are becoming increasingly popular in the West and elsewhere.

Commercial wettable DDT is widely used in place of soluble pine oil emulsions. A single dipping or spraying with a suspension containing 0.5 percent wettable DDT is probably the best procedure. This material is relatively inexpensive and very easy to use, but the contents of the dipping vat must be stirred frequently to prevent settling-out of the DDT, and power sprayers should be equipped with rotary agitators.

Limited experiments under controlled conditions indicate that benzene hexachloride is capable of eradicating cattle louse infestations with a single treatment. Excellent results have been obtained using as little as 0.25 percent of benzene hexachloride, containing only 11.5 percent of the gamma isomer, in soluble pine oil emulsions. Moreover, the emulsions appear to have ovicidal properties.

**Measures for controlling sheep ticks**

Cube and derris powders, containing 5 percent rotenone, at the rate of 6 ounces per 100 gallons of water have been used successfully to eradicate sheep ticks, *Melophagus ovinus*, from heavily infested flocks on a single dipping, under range conditions. To meet all possible contingencies, some sheep-raisers prefer to use \( \frac{1}{4} \) pound of cube or derris per 100 gallons of water. No detergent is required, the water may be cold, and animals should be held in the vat for approximately one minute to assure thorough saturation of heavy fleeces. Preparation of the dip is rapid and inexpensive.

Both wettable DDT and DDT in oil emulsions, in 0.2 percent concentrations,
have been found to eradicate sheep tick infestations with a single dipping. Such preparations have also resulted in satisfactory louse control on both sheep and goats, and are especially useful where dual ranching is practiced. In making up early DDT-oil-water emulsions, petroleum oils were largely employed. Pen experiments, however, have subsequently revealed that soluble pine oil is probably superior to other emulsifiable oils for the purpose. While large scale field tests with this material have not yet been conducted, limited tests indicate it to be altogether safe and effective.

Limited trials with benzene hexachloride indicate that this insecticide is remarkably effective against sheep ticks. As little as 0.02 percent of the compound in soluble pine oil and water destroys the motile forms. At this exceedingly low dilution, benzene hexachloride is not puparicidal but does destroy the newly hatched ticks for a period of about 1 month.

Some additional use of DDT

Although there is no evidence that DDT is superior to Smear 62 for the destruction of screwworms and controlling the infestations, or to Formula M.S. 793 F. for the destruction and control of fleeceworms, recent trials in Australia of the use of DDT against blowflies revealed that the dipping of sheep in aqueous preparations containing 0.5 percent of the insecticide affords good protection against blowfly strike for periods of 4 to 6 weeks. The presence of the chemical interferes with the deposition of eggs by the flies, complete batches of eggs being rarely laid on treated sheep.

Dips containing 0.2 percent DDT, prepared by adding 10 pints of a stock solution to 100 gallons of water, have been found to destroy goat lice and to give residual protection against reinfection for about 1 month. The stock solution is prepared by adding 1 part by weight of DDT to 5 parts of soluble pine oil.

Cattle are protected from hornflies for periods of at least 2 weeks through the use of sprays containing 0.2 percent DDT, and in many instances concentrations of only 0.1 percent of the chemical appear to have given as good results.

Washes containing 0.8 percent DDT in 4 percent soluble pine oil and water have been found useful in destroying the winter tick of horses, Dermacentor albipictus. Some residual protection is afforded by the treatment but its duration has not been determined.

Preparations of both wettable DDT, and DDT in oil-and-water emulsions, in concentrations of 0.75 percent DDT, effectively eradicate heavy infestations of the common sucking louse of swine by a single dipping.

Progress in control of bovine trichomoniasis

With the cooperation of a few owners of beef and dairy herds, veterinarians of the Zoological Division of the Federal Bureau of Animal Industry have achieved a promising degree of success in the development of measures for the control of this venereal disease of cattle, which affects the reproductive systems of infected animals. The proposed program of control involves hygienic breeding of a sort designed to circumvent the spread of infection from diseased bulls to heifers and cows, and from diseased cows to bulls. All infected bulls in herds, as determined by the breeding history and also by the presence of the causative organisms (Tri-
chomonas foetus) in the prepuce, are withdrawn from service; nonpregnant and presumably unexposed females are artificially inseminated with semen from a known uninfected bull; and, finally, all cows that calved normally are rested for at least 90 days before being served by an uninfected bull. Because infected bulls ordinarily remain spreaders of trichomoniasis as long as they serve susceptible females, a specific, effective treatment for curing them is a desired adjunct to practical control measures. Although nothing of this nature has yet been developed, a few instances of success have been achieved, under experimental conditions, by courses of treatment with iodine compounds.

**Sodium fluoride removes large roundworms from swine safely and effectively**

All yardsticks by which one can measure the extent to which a new treatment is being used indicate that the sodium fluoride treatment for the removal of ascarids from swine has received wide and successful field application. It is still too early to appraise fully the risks and advantages of the treatment under field application, and there are probably few who would regard this new treatment as the ideal, yet the experience to date, both in the laboratory and in the field seems to bear out all the advantages that have been ascribed to it. The treatment consists in the administration of the chemical (technical grade) in dry ground feed at a concentration of 1 percent for 1 day on a mixture of 1 part by weight of sodium fluoride and 99 parts of ground feed. The treatment is easy to give and is more efficacious than phenothiazine or oil of chenopodium. Its most serious drawback is the dangerously toxic nature of the chemical, should it be used unwisely or come into the hands of children and others who are not familiar with it. It is quite safe to use as an anthelmintic for swine, when employed as described above, but because the chemical is a gastrointestinal irritant, its administration to hogs is contraindicated by the presence of gastroenteritis in any form.

**Wide and profitable use of phenothiazine**

Phenothiazine continues to be the treatment of choice for controlling many types of gastrointestinal roundworms affecting the several classes of livestock. Of particular note are the wide uses in sheep of (1) the program of winter treatment of breeding stock and (2) the system of free-choice administration of the chemical in salt. Some sheep raisers rely upon one or the other of these systems, others employ a combination of the two, and some practice free-choice medication on a year-around basis.

In connection with the use of free-choice medication as a grazing season measure, all research and field experience shows that the success of the measure depends upon its prompt institution at the very beginning of the grazing season and upon using the measure prophylactically with reasonably "clean" sheep on "clean" pastures.

Finally, considerable surveillance must be exercised over the flock and therapeutic treatments given whenever animals become unthrifty or show other evidence of parasitism.

Reports received by the U. S. Department of Agriculture from extension agents and livestock specialists in 19 States show that improved methods of controlling sheep parasites are paying good dividends in the form of plumper market lambs and better condition of breeding stock. Much of the improvement is credited to
the use of phenothiazine. Reports typical of those received previously indicate that the research findings have spread unusually quickly among sheepmen who have long suffered heavy losses from parasites in their flocks. An account of progress in Kentucky states that, whereas the percentage of late lambs grown out to good market weights and finish was small before the advent of phenothiazine, now their average weight is 10 to 12 pounds greater and their condition better. The change has brought benefits worth a million dollars a year to the Kentucky sheep industry.

The quality of lambs marketed by North Dakota sheepmen is reported to have increased at least 10 percent since the extensive adoption of parasite-control programs, comprising the use of phenothiazine and better sanitation and nutrition. The great majority of sheep and goat raisers in Texas use the drug as a drench, in a salt mixture, or in a combination of both methods. From West Virginia, reports of farmers, county agents, and market officials all give the use of phenothiazine credit for an unusually high-grading crop of fat lambs. Reports from individual counties in various States indicate that as high as 90 percent of flock owners are controlling sheep parasites more effectively than in previous years and that most control programs include the use of phenothiazine in salt licks or as a drench. Although the benefits of parasite control are most apparent in market animals sold by weight, the reports mention also noticeable improvement in the condition of breeding stock.

Other developments in the treatment of parasitism in sheep

During the past 5 years, trials with lead arsenate for the removal of tapeworms (Moniezia) from ruminants, chiefly sheep, have been reported in veterinary journals by McCulloch and McCoy of Washington State College, by Radeleff, a practitioner in Kerrville, Texas, and by Ward and Scales of Mississippi State College, all of whom called attention to the apparent safety and clinical efficacy of the treatment. These trials grew out of an earlier report by workers of the U. S. Bureau of Animal Industry of the efficacy of lead arsenate against certain tapeworms of poultry—a treatment that could not be generally used, however, on account of its toxicity to chickens. During the past 2 years, this proposed taeniacide for sheep has been investigated by the Bureau, largely in cooperation with workers at the South Dakota State College Experiment Station, with some important, although not entirely conclusive, results. In the limited trials, the critical efficacy of lead arsenate in doses of 1 gram per lamb was determined to be approximately 90 percent, and the treatment was well tolerated. Moreover, administration of the treatment to scouring lambs in western South Dakota seemed to accomplish the dual result in removing the tapeworms and curing the scouring condition. Although there is much still to be learned about the comparative superiority of this treatment, and of its safety, as well as about its application to problems of scouring among sheep, the results to date suggest that the treatment in question offers considerable promise of an effective taeniacide for sheep and other ruminants.

Although there is no evidence at present that a treatment superior to carbon tetrachloride for the removal and destruction of sheep liver flukes will soon be found, some interest naturally follows the trials in sheep of the hexachlorethane-bentonite suspension that was recently developed as a fasciolicide for cattle. Tests
carried out by Federal workers in the Gulf Coast area of Texas have indicated that the treatment is efficacious and, with some exceptions, well tolerated. Toxic reactions observed thus far have occurred in areas where the sheep appeared to be also intolerant of the carbon tetrachloride treatment. In the main, doses of 30 cc., containing 15 grams of hexachlorethane, administered as a drench, were employed.

Since the discovery of filarial dermatosis of sheep by Dr. H. E. Kemper of the Federal Bureau of Animal Industry in 1933, the disease has been found in restricted areas of New Mexico, Arizona, Colorado, and Utah, and an effective treatment for the condition has been recently developed. Under experimental conditions, complete healing of skin lesions followed upon appropriate treatment with either anthiomdine or fuadin, and these drugs offer some promise of being effective in single large doses, but the most practical treatment, considering the availability of materials and risks of medication, is probably a course of 8 weekly or semi-weekly intramuscular injections of tartar emetic and glucose. Each injection consists of 30 cc., containing 0.3 gram tartar emetic and 4 cc. of 50 percent glucose solution, in distilled water.

**Improved methods for controlling worm parasites and cecal coccidiosis of poultry**

Experience of the past year suggests that phenothiazine and nicotine can be used effectively and easily in combination for the treatment of chickens and turkeys infested with large roundworms and cecal worms. Under experimental conditions the feeding for a few days of a medicated mash consisting of 15 grams of 40 percent nicotine sulfate (commercially sold as Black Leaf 40), 151 grams of phenothiazine, 287 grams of bentonite, and 44 pounds of chick mash removed practically all of the ascarids and heterakids from infested birds. Under field conditions, moreover, the feeding of this medicated mash for 3 consecutive days at intervals of 3 weeks has given good control of both of these important species of poultry parasites over extended periods of time.

For controlling cecal coccidiosis, caused by *Eimeria tenella*, sulfaguanidine has been used with good success both experimentally and in practice. Although some other related drugs will probably one day prove superior, none has been studied more extensively than sulfaguanidine, and about no other do we have sufficient information to be in a position to suggest practicable control procedures. Birds should be placed on a mash containing 1 percent sulfaguanidine as soon as bleeding starts or as soon as possible when an outbreak of coccidiosis is imminent. At the end of 2 days, the medicated mash should be withdrawn and ordinary mash fed for the next 3 days. The birds should then be given the medicated mash for 1 day and plain mash for 3 days, this system being repeated until symptoms subside. Treated birds are usually immune to subsequent infection. The 1 percent medicated mash is also useful in aborting an outbreak of intestinal coccidiosis, but in this case, the medication must be continuous, although it probably should not be given for longer periods than about 1 week.

In connection with this discussion of newer developments in the control of poultry parasites, attention should be called to the fact that the gapeworm treatment, barium antimonyl tartrate, has been found to be a very satisfactory remedy for the destruction of these parasites in pheasants.
CRYSTAL-VIOLET HOG-CHOLERA VACCINE

By C. G. Cole, D.V.M.

Hog Cholera Laboratory, Pathological Division, Bureau of Animal Industry,
Agricultural Research Administration, U. S. Department of
Agriculture, Ames, Iowa

AND

R. R. Henley, B.S., M.S.

Pathological Division, Bureau of Animal Industry, Agricultural Research
Administration, U. S. Department of Agriculture, Washington, D. C.

INTRODUCTION

Crystal-violet hog-cholera vaccine was first prepared in 1934 under the direction
of the late Doctor Marion Dorset who originated the method of immunizing swine
against hog cholera. Since the death of Doctor Dorset accumulation of data on
various phases of the production and practical application of the vaccine have been
conducted under the direction of Doctor H. W. Schoening, In Charge of the Patho-
logical Division.

A preliminary report was made in August 1936 at the meeting of the American
Veterinary Medical Association in Columbus, Ohio. A paper “Field Tests of
Crystal-Violet Vaccine for the Prevention of Hog Cholera” was presented to this
association December 4, 1940.

Crystal-violet vaccine is now produced commercially in the United States and
by several foreign governmental agencies, including England, Brazil, Argentina,
and Mexico.

PRODUCTION

The method of preparing crystal-violet vaccine has been modified several times
during the era of experimental investigations. It is now prepared by adding 20
parts of a solution of crystal violet in glycerine to 80 parts of defibrinated blood from
cholera-infected pigs. The solution contains crystal violet one part in 400 parts
of glycerine. After the solution and blood are thoroughly mixed the product is
incubated for 14 days at 37.5°C. This formula has very materially improved the
physical and bactericidal properties of the vaccine. In the earlier experiments
it was not uncommon to find lots of vaccine which were contaminated when re-
moved from the incubator. Some lots of contaminated vaccines have been tested
and found potent when freshly prepared but upon later tests have been found to be
impotent. When vaccines are prepared by the above-described formula practically
all lots are sterile after two weeks’ incubation. Tests of vaccines produced by this
method have demonstrated that the disease-producing properties in the blood are
destroyed after incubation for five days. Only sterile vaccines are used in field
experiments or distributed for use by cooperators.
CRYSTAL-VIOLET HOG-CHOLERA VACCINE

VACCINE TESTING

The test now used in experimental vaccine production by the Bureau is as follows: Two pigs are injected with 1 cc. of vaccine, two with 2.5 cc., two with 5 cc., and two with 10 cc. Three pigs from the same lot are left untreated to serve as controls. The group is isolated for three weeks and then exposed by the injection of 2 cc. of virus for each pig. The pigs given 1 cc. doses are used primarily to detect vaccine of high potency and those given 10 cc. doses are used to determine whether the virulence has been destroyed. Since the time that the 1 cc. dose has been used in the test, the control pigs have been allowed to die or recover instead of being killed for virus. When the control pigs die of cholera and those given 1 cc. do not, it is reasonable to presume that they were protected by the 1 cc. dose of vaccine. Failure of the 1 cc. dose to protect does not disqualify the vaccine in case the protection in the other doses is satisfactory. Whenever a new lot of vaccine is tested, a previously tested old lot is retested as a check or control vaccine.

FARM EXPERIMENTS

In November 1935, the first farm herd was treated with crystal-violet vaccine. Since then 361 herds containing 19,410 pigs have been treated in the territory where the experiment station at Ames, Iowa is located.

At the time the hogs are sold on the market, a few are purchased from as many herds as possible and are tested for immunity at the station. The total number of vaccinated farm hogs tested for immunity by exposure and virus injection is 1,283 from 318 herds. The total number of survivors in these tests is 1,204, or 93.8 percent; total deaths, 79, or 6.2 percent. Of the survivors, 152, or 11.9 percent, had severe reactions and were not considered adequately protected although they did survive. The ones considered adequately protected, which include those that remained normal or had only a slight reaction, is 82 percent.

Since the latest change in formula to the combination of glycerine and crystal violet, the results of immunity tests of farm herds have been as follows:

Of 128 pigs from 39 herds exposed to cholera at market age, 96.1 percent survived and 3.9 percent died. Of the 96.1 percent survivors, 7 percent had severe reactions, leaving 89.1 percent considered adequately protected. Had it not been for almost complete failure in immunizing one herd, the results would have been much more favorable. However, in three farm herds treated with the same serial of vaccine results of immunity tests were satisfactory. The cause of failure in the one herd could not be satisfactorily explained. The only deviation from normal conditions that could be determined was that this herd was owned by a farmer who was cooperating in a genetics experiment.

EFFECTS ON FARM PIGS OF DIFFERENT DOSES OF VACCINE

Since the beginning of farm experiments with crystal-violet vaccine conducted by the Bureau, the dosage has been 5 cc. for pigs up to 75 pounds in weight and 10 cc. for pigs above that weight. The standard dose recommended by commercial producers of vaccine is usually 5 cc. for all sizes. The results of exposure, at market age, of the farm hogs treated with the crystal violet-glycerine vaccine in 5 cc. and
10 cc. doses are as follows: The immunity was satisfactory in 83.8 percent of the pigs given 5 cc. doses and in 95 per cent of those given 10 cc., making a difference of 11.2 percent in favor of the 10 cc. dose.

**DURATION OF IMMUNITY**

It is difficult to determine the duration of immunity by tests of vaccinated pigs in farm herds. This is partly because most of the farm pigs are marketed within nine months after vaccination and partly because conditions on the farms cannot be controlled. In order to determine the duration of immunity under controlled conditions three experiments have been conducted. The first was begun in 1943 when eight shots weighing from 65 to 80 pounds were treated with vaccine. These pigs, with two untreated controls from the same lot, were exposed by virus injection, half at eight months and half at 12 months after vaccination. Of the ones exposed at eight months, two had slight reactions and two remained normal—the control pig developed acute hog cholera and was killed for virus. Of the ones exposed one year after treatment the results were the same, two remained normal and two had slight reactions—the control pig, which at the time of exposure weighed 350 pounds, died of acute cholera.

The second experiment to determine the duration of immunity was started in August 1944. In this experiment each of 28 pigs was treated with 5 cc. of vaccine and 10 pigs from the same lot were left as untreated controls. A group of four vaccine-treated pigs and one or two control pigs was exposed four weeks after treatment and the remaining groups were exposed at nine week intervals along with one or two control pigs. The last group was exposed 58 weeks after treatment. One pig in the group exposed at 13 weeks died, one in the group exposed at 22 weeks and one in the group exposed at 58 weeks showed a slight reaction and 25 remained normal. Twenty-seven of the twenty-eight head were adequately protected. Of the 10 control pigs all developed acute hog cholera—eight were killed for virus and two died. In this case satisfactory immunity lasted for one year, one month and five days.

The third experiment was started September 14, 1945 using the same serial of vaccine that was used in the 1944 experiment. In this experiment 21 pigs were treated with 5 cc. each of vaccine and nine pigs from the same lot were left untreated to serve as controls. The first group with two control pigs was exposed four weeks after treatment and the remaining groups were exposed at nine week intervals along with one or two control pigs. The last group in this experiment was exposed October 25, 1946, 11 days over 13 months after treatment. All vaccine-treated pigs survived exposure by virus injection in 2 cc. doses plus contact exposure with the sick controls.

Previously it has been stated that protection by vaccine treatment lasted only eight months because most exposures in past experiments were made at that time. The experiments reported in this paper indicate that immunity persists at least one year. Furthermore, in these experiments a vaccine that protected for 13 months when first prepared retained for one year its ability to afford similar protection.

All pigs in these experiments were kept in a barn used for susceptible pigs from
CRYSTAL-VIOLET HOG-CHELERA VACCINE

the time they are purchased until used in experiments. Therefore, in addition to the controls from the same lots hundreds of other susceptible pigs from a number of different lots were kept in this barn for varying periods during the course of these experiments. Thus it is definitely known that they were not subjected to any exposure which would result in increasing their immunity.

COMBINED USE OF VACCINE AND SERUM

Previous experiments have been reported which indicated that when anti-hog-cholera serum and crystal-violet vaccine were administered to pigs at or near the same time, the serum interfered with the normal action of the vaccine.

A statement by Boynton, Woods and Wood in the November 1938 Journal of the American Veterinary Medical Association led to some confusion and caused some inquiries on what seemed to be conflicting statements about the combined use of anti-hog-cholera serum and vaccine. The statements were not in reality conflicting since they were made about two different products, crystal-violet vaccine and Boynton Tissue Vaccine. While similar results would be expected from the two products there is no experimental evidence to show that their actions are identical.

Since the statements made in Bureau publications that serum interfered with the action of crystal-violet vaccine were based on a rather limited number of experiments it was considered advisable to obtain more data on this subject. During the past summer the following experiment was conducted: Sixty-five Hampshire pigs from one source ranging in weight from 50 to 75 pounds were divided into 13 groups of five pigs each and used as follows: One group received serum alone; one, vaccine alone; one, serum and vaccine simultaneously; four, serum followed by vaccine, one of the four groups receiving the vaccine one week after serum, one group two weeks, one group three weeks and one group four weeks after the serum treatment. Four other groups were given vaccine followed by serum—one of these four groups was given serum at one, two, three, and four weeks, respectively, after vaccine treatment. As controls on this experiment one group of five pigs was treated with serum and virus and a group of five was left untreated. All groups were held for three months, when each pig was injected with 2 cc. of highly virulent hog-cholera virus.

There was no evidence of immunity in the group treated with serum alone or in the group treated simultaneously with serum and vaccine or in the four groups treated with vaccine one, two, three, or four weeks after the administration of anti-hog-cholera serum. All pigs in the group treated with vaccine one week prior to serum treatment developed acute cholera. The group treated two weeks prior to serum treatment was fairly well protected. Those treated with vaccine alone and with vaccine three and four weeks prior to the administration of serum were completely protected. The group treated with serum and virus remained normal and the untreated controls all developed cholera.

This experiment indicated that it is useless to treat pigs with crystal-violet vaccine and serum simultaneously or at any time within four weeks after serum treatment. The same results would probably be continued as long as the serum-alone immunity lasts. The duration of serum-alone immunity has been reported anywhere between three weeks and three months. In this experiment the serum-alone immunity persisted for four weeks but had expired at three months. The experiment also
showed that when vaccine is administered three weeks or more prior to the administration of serum, a satisfactory immunity develops. Whether such an immunity is superior to vaccine-alone immunity is unknown.

PRESENT OBJECTIVES

Although the crystal violet-glycerol vaccines now being produced are an improvement over the formerly used crystal violet-phosphate vaccines, further improvement is believed possible. One of the chief improvements needed is higher and more uniform potency. In producing vaccines for field use, those derived from the blood of a number of different pigs are mixed to form a batch or serial. Although it is possible quite regularly to prepare large lots of vaccine of satisfactory potency, vaccines from individual pigs, or sublots of vaccines vary in potency. If it were practical to test individually all sublots and to discard all except the most potent, vaccines of very high potency could be produced. Another method of accomplishing the same end would be to find methods for preparing sublots of uniformly high potency. To obtain information on that possibility, studies have been made of the factors that might influence potency. Among these factors are: (1) the amount of virus in the blood converted to the vaccine, (2) the dose of virus given the donor, and (3) the strain of virus used.

AMOUNT OF VIRUS PRESENT IN BLOOD CONVERTED TO VACCINE

It has long been known that vaccines from different pigs vary in potency just as viruses from different pigs vary in virulence and as anti-hog-cholera serums from different hyperimmunes vary in potency. This is one of the reasons why such products are pooled in large scale production. Since the virulence of virus from different pigs is known to vary, the possibility that the virulence of a virus influenced the potency of a derived vaccine was first investigated. These studies involved the titration of the blood to determine the virulence of viruses derived from individual pigs, conversion of the viruses to vaccines, followed by comparative tests of the potencies of the vaccines derived from the viruses of different virulence. Results of the titration studies of a number of different viruses obtained in the work were published in a paper entitled “Concentration of Hog Cholera Virus in the Blood of Artificially Infected Swine at Different Stages of the Disease.” A minimum lethal dose of virus between 1/2,500,000 cc. and 1/1,000,000 cc. was reported in that work.

Vaccines were prepared from each of the 16 viruses mentioned in that paper and from 4 other viruses that had been titrated. The 20 vaccines were each subjected to one or more potency tests. Some vaccines of high potency and some of low potency were produced from blood of high virus content and some vaccines of high and some of low potency were produced from blood of relatively low virus content. Thus, no definite relation was found between the virulence of a virus blood and the potency of the derived vaccine.

AMOUNT OF VIRUS GIVEN DONOR

In the course of the study regarding the relation of the virus content of a blood to the potency of the derived vaccine, there were indications that the potency of a vaccine was influenced by the amount of virus-blood given the donor pig. A series of experiments was therefore carried out in which pigs were injected with different doses of virus and vaccines then prepared from the blood of each pig. In each experiment at least two pigs were used, one receiving a large dose of virus, and the other a small one. The range of doses was from 1/1,000,000 cc. to 10 cc. In all, 14 lots of vaccines were prepared and tested. In some instances vaccines from pigs that received a large dose of virus were more potent than those from pigs that received a small dose, but in other instances, the contrary was true. No relation was therefore found between the amount of virus given a donor and the potency of the vaccine derived from the donor's blood.

STRAIN OF VIRUS

Another factor that may influence the potency of a vaccine is the strain of virus given the donor. Doctor T. M. Doyle* found in England that a vaccine prepared from an English strain lacked potency when tested against either the homologous strain or a strain of American origin whereas vaccines from American strains protected against viruses of either American or English origin. In our own work, some tests have been made with vaccines derived from different strains. In one instance six different strains were selected from 36 samples of commercial virus. They were selected for virulence. Vaccines from some of these strains were more potent than those from others. However, only one vaccine was prepared from each strain, and extraneous factors were not excluded. Incidentally, B.A.I. vaccines protected against each of the virulent commercial strains. In another series of tests, a vaccine from a particular strain of virus appeared definitely superior to other vaccines but in later tests, vaccines from that particular strain were not outstanding. So far in our own work, no evidence has been obtained that the strain of virus used is a deciding factor in influencing potency.

As one after another possible factor has been excluded as definitely controlling potency, attention has been directed to the possibility that the potency of a vaccine is influenced by some peculiarity of the pig. To determine the condition of the donor pig that might influence potency, is one of the objects of our present study.

VARIATIONS IN IMMUNITY RESPONSE

Just as vaccines from different donors vary in potency, so may pigs from different sources respond differently to vaccination. This has occurred when pigs in different places were treated with vaccine from the same bottle and later exposed to the same virus or to the same strain of virus. Pigs in one place were adequately protected; in the other place they were not. Such instances have not been frequent but they have occurred and point to the need of further study. At the present time, it is known, as has been shown in the section regarding the combined use of serum and

vaccine, that passive immunity interferes with the effectiveness of crystal-violet vaccines. Results with pigs from serum-virus treated dams point in the same direction. Whether other factors exert similar influence remains to be studied.

PRESERVATION OF VIRUS

Another objective is to find methods of maintaining or preserving good strains of virus. One of the difficulties in evaluating the results of a series of experiments on the same problem has been that, since phenolized virus deteriorates in a relatively short time, the same exposure virus cannot be used over long periods. Consequently, different pigs in different experiments of the same series have, of necessity, been exposed by different serials of virus. Further, since phenolized virus deteriorates, different vaccines have, of necessity, been prepared from donors that were inoculated with different serials of virus. The use of different viruses either as exposure or inoculating virus introduces a variable which complicates results and interferes with conclusions. In order to find a method of preserving good strains, and thus eliminate that variable, studies are being made of unphenolized viruses that have been kept frozen at low temperatures and of their phenolized controls that have been kept at ordinary refrigerator temperatures. Results have shown that of six pairs of such samples tested after holding for six months, the frozen samples have shown no diminution of virulence while five of the phenolized samples failed to produce disease. Lots of virus have also been lyophilized and we have found, as have all others who have worked with such viruses, that they usually retain their virulence for relatively long periods.

Although difficulties remain to be overcome before crystal-violet vaccine will attain its full usefulness, the commercial production of the product is increasing. During the year ending June 30, 1946, 4,457,592 cc. of crystal-violet vaccine were produced commercially in the United States. The present product has advantages over that produced only a few years ago. Efforts to improve the product and increase its usefulness are being continued and should result in a product of still greater usefulness and dependability.
REPORT OF COMMITTEE ON TRANSMISSIBLE DISEASES OF SWINE


The livestock sanitary officials in the states generally considered to be the region of this country where swine production is a major agricultural activity, were again canvassed by questionnaire for the purpose of obtaining information relative to the prevalence of certain contagious and transmissible diseases of swine.

The objective was to learn: First, was there a trend toward an increase in the occurrence of the more important contagious and transmissible bacterial, viral, parasitic and protozoan diseases of swine during the current year (1946) over the past year (1945); Second, was there a trend in the direction of a decrease in any of these diseases in 1946 over 1945; third, was there no particular change with respect to their occurrence in 1946 as compared with 1945?

A similar canvass covering the same geographical area was made a year ago, and on the basis of the returns the Committee was in position to report that the prevalence of the transmissible diseases showed in general that there was a definite decrease of them in 1945 over 1944. By and large, the returns this year indicate a still further decrease in many of the diseases, and especially for those infectious diseases in which the death rate often reaches high proportions.

It was interesting to find that a majority of the states reporting indicated that there was a lesser amount of hog cholera outbreaks in 1946 than in 1945. The remainder indicated that the prevalence of this disease in 1946 was comparable to its prevalence in 1945. The fact that not a single report suggested that the disease was on the increase seems worthy of special mention.

Influenza of swine, another of the viral diseases of this species, was recorded as being less prevalent in the present year than in the previous year by most of the states. Likewise, a majority of the reports show a decline in the incidence of swine erysipelas. In this connection, only one state reports an increase in the amount of this disease.

Brucellosis in swine, according to the returns, is increasing. This was true of the returns collected in each of the past two years. There was nothing to indicate that there is a lesser amount of brucellosis in swine in any of the states included in the survey.

With respect to tuberculosis, the enteritis-complex, swine pox, scabies or sarcoptic mange, pulmonary strongylosis and ascariasis, most of the reports indicated that there was no particular change in their prevalence during the present year when compared to their prevalence during the previous year. It might be important to note that three of the reporters record an increase in the occurrence of sarcoptic mange, and if it were possible to obtain a definite statistic of the incidence of this
disease on a very large segment of the swine population, it is quite probable that the figure so obtained would surpass that which is generally suspected.

The questionnaire sought information on the occurrence and extent of Aujeskey's disease (pseudo-rabies) but for the most part the returns indicated that no reports of its occurrence had come to the attention of the animal disease control agencies.

The Committee wishes to take this opportunity to gratefully acknowledge the prompt cooperation of the livestock sanitary officials to whom our requests were submitted.
THE EFFECT OF WORLD WAR II ON MEAT AND MILK HYGIENE

BY JOHN S. KOEN, D.V.M.

Veterinarian, Interstate Inspection Division, Bureau of Animal Industry

World War II was of such magnitude that it had a decided effect on practically every person in the world and on almost every phase of human endeavor. Such a conflagration necessarily affected the meat and milk inspection services of the nation. Believing the members of this Association would want to know just what effect World War II has had on meat and milk hygiene, I have made requests of several agencies to furnish data containing such information. The Bureau of Animal Industry has provided information showing how the war affected the Federal meat inspection service. The Surgeon General's office of the War Department was asked to furnish a report showing how World War II affected military milk inspection. Inquiries were also sent to states and cities in various sections of the country for reports on their meat and milk inspection services.

THE FEDERAL MEAT INSPECTION SERVICE

The Meat Inspection Act established in 1906 was designed to prevent the use, in interstate or foreign commerce, of meat and meat food products which are unsound, unwholesome, or otherwise unfit for human food.

The major purposes of the present system of meat inspection may be itemized under 10 main categories. Though they are familiar to many of you, I repeat them here because of their direct bearing on the present subject. They are: (1) to examine food animals including cattle, calves, sheep, swine, goats, and horses prior to slaughter to eliminate diseased animals; (2) to conduct a thorough post-mortem examination of each animal at the time of slaughter to search out and eliminate diseased and otherwise unfit meat; (3) to destroy diseased and otherwise unfit meat; (4) to see that meat and meat products are kept clean and wholesome during the stages of preparation into articles of food; (5) to guard against the use of harmful preservatives and other deleterious ingredients; (6) to cause sound and wholesome meat and meat products to be marked as having been "inspected and passed"; (7) to require informative labeling and to prevent the use of false and deceptive labeling on meat and meat products; (8) to certify meat and meat products for export; (9) to inspect meat and meat products offered for importation into this country; (10) to examine meat and meat products for compliance with specification requirements of governmental purchasing agencies. In addition, the meat inspection service conducts investigations, including laboratory studies, to assure proper post-mortem diagnosis and disposition of carcasses in unusual cases; and to study methods of handling and treating carcasses and tissues to meet requirements of meat inspection regulations. It also conducts research on abnormal conditions in meat or its products through investigations of feeding, management, or packing procedures or of diseases or parasites to which the conditions might be attributed.

Meats and meat food products prepared in a federally inspected establishment are required to be marked with the words "U. S. inspected and passed" and the
number of the establishment. Thus, the little purple stamp with which we are all familiar, appearing on carcasses and fresh meat, is the assurance of the U. S. Department of Agriculture that the meat is derived from animals found to be sound and healthy at the time of slaughter and that the product has been handled in a sanitary manner in a clean plant.

The meat inspection service has for many years been a fundamental influence in the production, marketing, and distribution of livestock and meat and meat products. Since approximately 7½ percent of all animals slaughtered for food are affected in some degree with abnormal or diseased conditions which are seldom apparent except to especially trained inspectors, it is necessary that such inspectors examine individually each animal slaughtered for food purposes. However, records of the service show that many of the conditions are minor and the carcasses are passed after removal and condemnation of affected tissues. Only about one-half of one percent of entire carcasses need to be condemned. Also, since meat and meat products are highly perishable and readily contaminated, their processing and packing must be conducted in adequately equipped plants under close inspectional supervision.

In order to supply the tremendous quantities of meat required by the armed services, for the public generally, and to fulfill our lend-lease commitments, the livestock and meat packing industries increased their production tremendously during the war years. The increased activity in the meat packing industry caused a corresponding increase in the functions of the meat inspection service. Not only was it necessary to provide inspection for long hours of speeded-up operations in the large packing centers, but it was also necessary to extend the inspection service to nearly 300 additional packing plants located in widely separated parts of the country. This activity called forth all the resourcefulness and skill of the inspectors engaged in this work. Moreover, the knowledge gained during many years of inspection experience was of great value in helping the meat-plant operators in doing their part in furnishing an uninterrupted supply of clean wholesome meat under most trying conditions.

The volume of operations under Federal inspection jumped from a total annual slaughter of some 82,000,000 animals just before the war to a peak of 118,000,000 three years later. There was a corresponding increase in the amount of processed meat food products such as smoked meats, sausage, lard, and canned meats of all kinds. The canned products included many new items for the armed services. Some of these, such as meat with gravy, ham and eggs, and spaghetti with meat show promise of considerable appeal to civilians during the post-war years.

Another illustration of the activities brought about by the war can be found in the report of the meat inspection service concerning its review and approval of plans for remodeling and new construction of packing plants. Last year, 961 such plans were presented for approval, an increase of 28 percent over the previous year. These projects, ranging in value from a few thousand dollars to more than two million dollars, show the trend toward modernization throughout the industry. This trend was stimulated by the spread of the inspection activities which confirmed the essential value of a sound thorough-going meat inspection policy. To help in this program of modernization, the meat inspection service has prepared and dis-
tributed a pamphlet giving the essentials of modern sanitary construction to meet operating needs as well as the necessities of inspection. You may obtain this pamphlet upon request if you have not already received it.

Last year, the meat inspection service prepared a two-reel film showing some of the more important phases of the inspection activity in a meat packing plant. Entitled “Meats With Approval”, it shows the steps of inspection from live animals through the slaughtering plant and the various methods of processing. We have the film here for showing immediately following this paper.

ARMY VETERINARY CORPS INSPECTION

The military forces took full advantage of modern methods of meat handling during the war. Hundreds of installations using the latest types of refrigeration, equipment, and facilities to preserve and handle meat properly were put into use wherever Army and Navy bases were established. This was a noticeable innovation as compared with the situation existing during former wars.

The meat inspection conducted by the Veterinary Corps was developed to a very high degree during this war. Beginning with meat inspected and passed for wholesomeness by the Department of Agriculture’s Meat Inspection Service, Army inspectors select the product on the basis of established grade and related quality standards and then follow up to see that it is properly handled through all phases of its preparation in Army camps and depots until it reaches the soldiers’ chow line. In foreign countries where a supply of federally inspected meat was not always available, the Veterinary Corps also set up ante-mortem and post-mortem inspection of slaughtering units conducted by local people or in some instances by Army personnel. Throughout this wide activity, it was necessary to bring about many adjustments of procedure involving changes in local customs and regulations. The net effect of this activity was a general raising of sanitary standards in areas near Army bases.

ANIMAL FOODS INSPECTION

A recent development in which many of you will be interested is the establishment of an Animal Foods Inspection Division in the Bureau of Animal Industry. Regulations issued by the Department, on November 14 of this year provide for inspection and certification of canned wet food for dogs, cats and other carnivora on the basis of standards established for a normal maintenance food. This new service is entirely voluntary. It is financed through payment of fees for the service rendered, under authority of the research and marketing act of August 1946. This form of inspection is being made available at the request of industry representatives and includes supervision of sanitary conditions in the plant, the ingredients that go into the canned food, accurate labeling, and all steps of its preparation. Dr. L. V. Hardy, who has had many years of experience in the Meat Inspection Service, is in charge of this new Division.

MILK INSPECTION

When we review the milk inspection of the country, we find an entirely different picture. The only federal law governing milk and milk products is the Pure Food
Law. This law permits the Food and Drug Administration to seize adulterated or filthy milk or milk products if they are shipped interstate. It has, however, no jurisdiction over products until they cross a state line. From a practical standpoint, this means that there is no federal law governing the production or processing of milk or its products.

A program of milk inspection does originate from the Surgeon General's office in the form of the U. S. Public Health Milk Ordinance. The U. S. Public Health Service Acts only in an advisory capacity in matters pertaining to milk sanitation. It is strictly a voluntary procedure whether any city accepts it or not. However, this program has been accepted by several cities. It has done much good wherever it has been accepted and its suggestions are carried out.

There are many states that do not have state laws to govern the production, processing, and distribution of milk and dairy products within the states. Some of the states answering the questionnaire state they are planning on such laws. The states now quite generally delegate to cities and towns the authority to pass milk ordinances to satisfy local conditions.

The general milk supplies of the larger cities in the United States are safeguarded by pasteurization. Many of our smaller communities, however, do not have this safeguard. To protect the public health, all general milk supplies should be properly pasteurized. A study of the outbreaks of milk-borne diseases in the United States reveals the value of pasteurization. None of these outbreaks have been due to properly pasteurized milk that has been handled in a sanitary manner after pasteurization.

The Reader's Digest for August 1946, in an article condensed from The Progressive by Howard Holman, entitled How Safe is Your Town's Milk furnishes quite a summary of very interesting statistics regarding the milk supply to many cities and towns of America. I suggest that you read, or reread, this article. It contends very strongly for pasteurization of milk. It would almost lead one to conclude that pasteurization is the answer to most milk problems. I agree, that at the present time, pasteurization is the only known method of making a general milk supply safe for human consumption. It should be remembered, however, that pasteurization does not make a dirty milk supply fit for human consumption. Only milk of a high quality should be pasteurized. Safe milk is not enough. It must be from cows free of disease, it must be wholesome and then when pasteurized it will be fit for human consumption.

Milk inspection that is worthy the name must be able to certify to the healthfulness of the source of milk—the cow. The healthfulness of the cow cannot be determined without a physical examination by a competent person who is trained in animal-disease work and can make proper decisions. Veterinarians are the only group so trained and who can render intelligent decisions concerning the health of the cows. The basic training of the Veterinarian is such that he can readily acquire the principles of dairy hygiene and make the sanitary inspections of the farms, the dairy barns, and the equipment for handling milk on the farm. They can advise and counsel with the dairymen and explain the relation of the animal disease to human health, and the sanitary measures needed to safeguard the milk to keep it wholesome.
The nearest approach to national supervision over the milk supply of the nation came through the inspection services of veterinary officers of the War Department during World War II. The Surgeon General's office has furnished a report on this work which is appended to this paper. Although this inspection covered only the milk and milk products used by the Army, it had its effect on the civilian milk supplies. The requirements of the Army were higher than those of many communities with the result that the milk of the community was improved. Whether or not these improvements will be maintained now that the war is over is a question that only time can answer. This association should lend its support to the proper answer.

I want to express my thanks and the thanks of the committee to the several health officials who so kindly gave us information to compile that portion of this report.

Finally, it is from a varied experience that I have arrived at the conclusions set forth in this paper. As a Foreman of Taggers, I assisted in the inauguration of the Federal meat inspection Act of June 30, 1906. For more than ten years I assisted as a veterinary inspector in the development of that work. Later, I inaugurated a municipal meat inspection service in one of our large cities that compared favorably to Federal meat inspection in every essential detail. For three years I supervised its operations. For two years, I had charge of milk and food inspection as well as meat inspection in that city. I have a deep and profound interest in this work from actual experience. I have tried to help it succeed.

THE EFFECTS OF WORLD WAR II ON MILK INSPECTION IN THE UNITED STATES

Fresh milk procured by the Army under veterinary inspection during peacetime reached a total of slightly over 35,000,000 pounds in 1939. The passage of the National Selective Service Act and the mobilization of the National Guard in the latter part of 1940 were reflected in the Army milk supply by the raising of the quantity purchased to nearly 55,000,000 pounds. The preparedness training of 1941 raised the requirement to slightly over 208,000,000 pounds. During 1942, the first year that the country was at war, the Veterinary Corps was called upon to inspect over 491,000,000 pounds, and as our armed strength increased, this quantity increased to over 854,000,000 pounds in 1943 and remained above 810,000,000 pounds during 1944. Because of the extensive movement of troops from this country to overseas theaters the quantity decreased to an average of approximately 60,000,000 pounds per month during the first half of 1945.

It was apparent by the middle of 1942 that it would be impossible to procure sufficient milk meeting the pre-war standards to fill wartime requirements. Consequently, a new specification was promulgated defining three types of milk one of which was of a lower quality than heretofore accepted by the Army.

Type I, "Certified Milk, Pasteurized," conformed with the current requirements of the American Association of Medical Milk Commissions Incorporated. The maximum standard plate bacteria count of the raw milk was not to exceed over 10,000 per milliliter, and the maximum count of the pasteurized milk was not to exceed 50 per milliliter.

Type II, "Local First Quality Milk, Pasteurized," No. 1, could be produced in

localities with milk ordinances conforming to the requirements for Grade A pasteurized milk as defined by the U. S. Public Health Service Milk Ordinance and Code, or its equivalent. The maximum allowable average standard plate count on the raw milk was 200,000 per milliliter, and the maximum count on the pasteurized product 30,000.

Type II, "Local First Quality Milk, Pasteurized," No. 2, conformed to the requirements of the milk ordinances of the community in which produced, provided these ordinances required higher quality milk than specified for Type III. The maximum average count allowable for the raw milk was 500,000 per milliliter, and the maximum count for the pasteurized product was 30,000 per milliliter.

Type III, "Milk Pasteurized," was an additional type of milk of lower quality than previously authorized for Army use. It permitted purchase of the better quality milk, previously used for manufacturing purposes, provided it was produced under satisfactory sanitary conditions, had an average standard plate count not exceeding 1,000,000 bacteria per milliliter prior to pasteurization, and not over 50,000 bacteria per milliliter after pasteurization.

This lowering of standards made a large volume of milk, heretofore inaccessible, available in several communities, and by careful supervision resulted in troops receiving an adequate supply of safe milk. It was the policy and practice to procure Type III milk only when an adequate supply of Type II milk was not available.

In 1942, due to the heavy concentration of troops, especially in the south and the shifting of populations, the long standing practice of each Army installation procuring its own milk supply locally was discontinued and the procurement of all milk was centralized under the Office of the Quartermaster General, with the Quartermaster Market Center system serving as the procurement agency. This was an excellent solution to the ever-growing problems, both in procurement and inspection. It made the operation of a milk inspection program on a nationwide scale not only feasible, but imperative, on the part of the Surgeon General. Experienced veterinary officers were held responsible for supervising and coordinating milk inspection within their geographically assigned areas, with the entire program being supervised, standardized and coordinated from the Office of The Surgeon General.

There were many new developments in the milk industry and in milk inspection due to wartime needs. One was the development of what was commonly referred to as "3 to 1 concentrated milk." This milk was concentrated from Type III milk in areas where milk was plentiful, and shipped to processing plants in areas where adequate supplies of fresh milk could not be procured. There it was reconstituted, blended with available fresh milk, pasteurized, and delivered in the usual manner. The Army Veterinary Service was largely responsible for the successful operation of this program which made fresh milk available to thousands of troops who could receive it in no other manner.

As a result of the demand for fresh milk for use on hospital ships returning patients from overseas, work done by veterinary officers at ports led to the development and use of frozen, fresh pasteurized homogenized, whole milk for this purpose. This product proved to be as palatable and acceptable as the fresh product. Originally, the keeping qualities appeared to be quite variable. However, recent in-
vestigational work conducted at the Army Veterinary School indicates that the product is fairly stable, and will keep well for several months, provided it is properly processed, frozen, and held continuously at a low even temperature.

Another development was the widespread use of the phosphatase test to determine the efficacy of the pasteurization process in milk plants. Though this test had been used to some extent by dairy inspectors prior to the war, it was the wartime inspection program that focused attention on its usefulness, and reiterated its value as an aid in milk inspection, with the resultant added impetus on its use both by the Army and civilian milk control agencies.

Another development was the wider adoption and use of the coliform test, and the demonstration that it had a definite place in milk control work. The importance and interpretation of the test and the significance of the presence of coliform organisms in milk was not well understood early in the war and caused considerable confusion. Methods for conducting and interpreting the test, as well as for proper corrective action following positive findings have been fairly well standardized, and are now generally understood and applied, with the result that still another aid is available to guide and assist the milk inspector in the field.

An interesting discovery was that fresh milk packaged in paper containers and held under refrigeration in the presence of dry ice would absorb sufficient carbon dioxide to develop an undue high acidity not indicative of souring. For this reason it was necessary for inspectors to resort to the organoleptic test rather than the acidity test when examining cars of milk that had been shipped long distances under dry ice refrigeration. Large quantities of milk were shipped under these conditions for as far as from Minnesota to Florida.

The operation of a nationwide inspection program brought forth certain significant observations from those in charge. It was found that the quality of a milk supply frequently could not be judged by the ordinance under which it was produced, processed, and handled. It was found that variations in quality of milk between areas having identical milk ordinances are sometimes fully as great as those between areas having widely varied ordinances. It appeared that the adoption of a universal milk ordinance would do much to improve the quality of fresh milk in some areas. At the same time it was evident that adoption of such an ordinance would be to no avail unless means for uniform enforcement were also provided. It was also evident that if the Army is to be assured of an adequate supply of milk of the desired quality throughout the country, it will continue to be necessary for the Army to specify its requirements and rely on its own veterinary service working in close cooperation with the U. S. Public Health and local milk control officials to insure that only safe, sound, wholesome milk of the quality specified is delivered to troops.

Throughout the Emergency, troops stationed in the United States received an average of more than one-half pint of fresh milk per man per day. This required more than 854,000,000 pounds during the peak year. That there were no milk-borne disease outbreaks in the Army during the wartime period is attributed to an efficient inspection system and the excellent cooperation of producers, handlers, and consumers, as well as the U. S. Public Health Service and other inspection agencies.

In meeting the demands of the Army, many producers and processors were im-
pressed with the necessity for using improved sanitary techniques. An example was set in many communities as to what could be accomplished by rigid inspection and enforcement of milk ordinance requirements. The Army inspection program gave added impetus and support to many local civilian inspection agencies. All this resulted in immediate benefit to the community.

This program has also instilled the desire in many soldiers for high quality milk. It has also made large numbers of military personnel, especially veterinary and medical personnel, many of whom will in the future be concerned with civilian milk control, conscious of the necessity for milk being produced and handled under proper sanitary conditions and of good quality.

Unquestionably, the wartime Army milk procurement and inspection program has made a beneficial and, it is hoped, a lasting impression on the nation's milk supply and milk inspection service.
THE GENESIS OF BOVINE UDDER INFECTION AND MASTITIS

3. DISCUSSION OF THE AGE FACTOR IN STREPTOCOCCAL (Str. agalactiae) INFECTION

BY JAMES M. MURPHY, V.M.D.

New Jersey Agricultural Experiment Station, Sussex, New Jersey

As a result of a seven-year study of the incidence of streptococcal (90% or more Streptococcus agalactiae) and staphylococcal infection of the udder in two herds, it was shown (23) that two factors commonly considered to be predisposing to streptococcal infection, "teat patency" and "obvious injury to the teat," could play only minor roles in the genesis of udder infection. This was based on the finding that the incidence of streptococcal infection increased with age whereas the incidence of staphylococcal infection was constant with age, and on the assumption that both the streptococci and staphylococci share the teat canal as a common portal of entry.

In proposing a three-phase concept (invasion-infection-inflammation) of the genesis of bovine udder infection and mastitis (23), it was reasoned that: 1) many kinds of microorganisms in small number probably enter the teat canal more or less constantly, 2) the number of these organisms is probably so small that they are not demonstrable ordinarily by the cultural methods usually employed (plating of fresh milk), 3) the usual cultural methods carefully applied to properly collected milk samples show only those bacteria that have reproduced rather extensively, 4) the suitability of the environment provided by the interior of the udder probably would be the deciding factor in the reproduction of such invaders, and 5) if any major predisposing or limiting factor exists, it would be expected to operate after the udder cavity had been invaded and prior to the advent of an inflammatory reaction, that is, in the infection phase.

It was next shown (24) that a major limiting or predisposing factor did exist in the case of streptococcal (Str. agalactiae) infection. This appeared as a highly significant relationship between the average age (as lactation periods) of the herds and the incidence of streptococcal infection (percentage of quarters infected) determined monthly for 84 months (7 years). The relationship was referred to as an age factor and inasmuch as it was a straight-line relationship beginning more than one year after the onset of milking life, rather than a curved-line relationship beginning at or near the onset of milking life and increasing with the passing of time, it was concluded that the age factor must be a function of age (in the sense of some change taking place in the animal body with the passing of time) rather than an

---

1 Paper of the Journal Series, New Jersey Agricultural Experiment Station, Rutgers University, Department of Dairy Husbandry.

2 "Formerly associate professor of Dairy Husbandry, N. J. Experiment Station, Sussex, N. J.; now professor of Veterinary Medicine, N. Y. State Veterinary College, Ithaca, N. Y.
effect of age per se (in the sense of a mere passing of time creating a greater opportunity for exposure to the infecting microorganisms).

In this light it was considered necessary to discard the "degree of exposure" theory and the "prior sensitization" theory (insofar as it is related to "degree of exposure"). Inasmuch as the "nonspecific mastitis" theory has been refuted by the later observations of its authors (9), the "hormone" theory of Francis (7) remains as the only valid streptococcal infection predisposing factor theory. Whether the age factor bears any relation to the action of hormones is not known and, until direct information is available, it should not be assumed that the mere validity of the "hormone" theory relates it in any way to the age factor.

It has been mentioned (23) that if any major limiting or predisposing factor exists it would be expected to operate in the infection phase but, with one exception to be noted later, there are no observations of any kind available at present by means of which any suggestion of the nature or cause of the age factor may be gained. However, while this lack of information prevents any direct alteration or nullification of the influence of the age factor in a cow population, there are certain observations of other investigators that appear to relate to the invasion-infection-inflammation concept, and to the age factor.

This is more readily appreciated when it is realized that the age factor is an expression of host susceptibility that develops after a variable period so that in a group of cows only one or a few individuals becomes susceptible at a time. When a group is sufficiently large and maintained under generally uniform conditions, this expresses itself as a straight-line correlation beginning at a time well after the onset of milking life. The nature of this phenomenon is such (24) that it is only possible to conclude that in an infected herd it is merely a matter of time until all individuals become susceptible and, according to the observations, become infected almost simultaneously. Any difference between individuals, then, becomes merely a difference in the time at which susceptibility develops. The susceptibility of Str. agalactiae infection does not appear to have any bearing on the presence of that organism in the environment, and the susceptibility of a group, therefore, would be related to age even though the group was free from Str. agalactiae infection.

In this connection it is of interest that Hastings, Beach and Johnson (9) reported an outbreak of Str. agalactiae infection in a herd of 24 cows maintained free from infection with this organism until about the middle of the third lactation period for most of the animals. The outbreak affected 13 (54.2%) of the cows in a period of seven months and the rapid spread was attributed to the high invasive power of the particular strain of Str. agalactiae isolated. Reference to the correlation and prediction data given in conjunction with the age factor (24) reveals that in the age range comparable to that of the Hastings, Beach and Johnson herd (the average of 3.5 lactation periods completed at time of the outbreak and the duration of seven months for the outbreak made, we may assume, an average age by lactation periods for that herd of approximately 3.5 to 4.0), our herds had an incidence of infection of from 33 to 43 percent of the cows. Furthermore, the standard error of estimate, when added to the high figure, would show a predicted incidence as high as 49 percent at an average age of 4.0 lactation periods. This is remarkably similar to the final incidence in the Hastings, Beach and Johnson herd and may indicate that the
extent of the outbreak was limited by the susceptibility of the herd and that the 
invasiveness of the strain of *Str. agalactiae* had little or no bearing on the rapid 
spread of infection.

In the demonstration of the *age factor* (24), the high degree of correlation between 
age and infection indicates that either *Str. agalactiae* is widespread in the environ-
ment even though the general sanitation is good, or that some source of the organism 
exists other than the environment. Hucker (11) demonstrated "mastitis strept-
tococci" in the mammary tissues of all of 24 cows that had passed through one or 
more lactation periods and were known to be "mastitis free." Examination of the 
data presented reveals that in only a few instances were the streptococci *Str. agalac-
tiae*. Bryan, Moore and Campbell (2) and Slanetz and Naghski (28) subsequently 
were unable, by more critical methods, to demonstrate *Str. agalactiae* in the udder 
tissue of cows whose mammary secretion prior to slaughter was also free from 
*Str. agalactiae*. Thus it cannot be said, on the basis of present information, that 
the mammary gland has been shown to harbor *Str. agalactiae* in its tissue, later 
to become visible in the milk as an infection.

Recent investigations, such as those of Reid, Farrell, Keyes and Shigley (27) 
and the Imperial Bureau of Animal Health (14), have shown that the periodic 
examination of milk from large numbers of cows by enrichment methods for a 
number of months reveals streptococci on one or more occasions in the secretion of 
almost all individuals. In the former case it was not shown that the samples were 
properly collected or that the streptococci were *Str. agalactiae*, and, therefore, the 
information is of little significance. In the latter case, however, because the meth-
ods were exacting and the investigation was limited to *Str. agalactiae*, the informa-
tion is of great significance.

The Imperial Bureau of Animal Health investigation (14) essentially confirmed 
the observations of Steck (30), Minett (22), Mattick et al. (20) and Bull et al. (3) 
that frequent examination and (or) special methods (enrichment) may reveal the 
presence of *Str. agalactiae* in the secretion of more mammary glands than would be 
shown by ordinary methods of agar medium culture of fresh milk or the microscopic 
examination of incubated milk. This condition in which small numbers of *Str. 
agalactiae* can be demonstrated in the milk only by special methods has been re-
ferred to as *latent infection* by Steck (30), as a *carrier state* in the British study (14), 
and as a *commensal inhabitation* by Klimmer and Haupt (17) and, as the titles show, 
is usually taken to indicate that such streptococci are inhabiting the interior of the 
mammary gland.

Yet the conception that true cultural latency represents an infection or inhabita-
tion of the interior of the mammary gland is only one of two primary possibilities. 
The other possibility is that this condition merely represents a revealing of the 
invasion of the cavity of the mammary gland at a time when the gland (and its 
secretion) does not provide proper conditions for the growth of the organism. The 
observation of Mattick et al. (20) that the presence of *Str. Agalactiae* could not be 
demonstrated in some samples even when the enrichment technic consisted of

---

*The terms *latent infection* and *carrier state* are used in a different sense by many 
workers to mean streptococcal infection demonstrable by ordinary methods in which 
no inflammatory response is exhibited at the time in the milk or gland.*
incubation of the milk samples at 37°C for 24 hours followed by culturing on Edward's medium, but that \textit{Str. Agalactiae} was easily demonstrated in such samples when diluted in sterile milk prior to incubation, indicates that this may be the case. They suggested that failure to grow in such cases might be attributed to bacteriostatic, bactericidal, or other substances or mechanisms in concentration sufficient to inhibit growth or even to destroy the organisms. From the data presented in the British study (14) it would appear that, in this case also, simple enrichment was not always productive of good growth of the streptococci.

The bactericidal or bacteriostatic property of milk as it comes from the udder has been the subject of some investigation, and the work of Jones and Little (15) is noteworthy in its consideration of this property in relation to udder infection. Among other things, these investigators found that the milk of all individuals examined showed such a property, that it was not so strong in some cows as in others, but that in any case observed it maintained its maximum effect \textit{in vitro} for not longer than eight hours. They felt that under the most favorable conditions it is possible that a few organisms which have recently gained access to the udder might be prevented from multiplying until they are flushed out at the next milking. They also considered that the substance might be more potent than they suspected. However, their main conclusion was that, inasmuch as the maximum duration of the bactericidal property was only eight hours, the usual period of 12 hours between milkings renders the substance more or less inoperative.

Yet in the case of an uninfected gland in the process of natural exposure to \textit{Str. agalactiae}, this is probably stated too simply. The invading streptococci might first contact the secretion at any time in the period between milkings and the effect of the bactericidal property would, therefore, be different. Then again, the \textit{in vitro} action of the property is not necessarily the same as the \textit{in vivo} action. For instance, one gains the impression from experience and from such works as that of Turner (32) that at times small amounts of milk may drain downward into the teat, so that the bactericidal ability of the milk in the teat might be reinforced during the period between milkings. This is particularly to be considered since Jones and Little (15) have shown that the \textit{in vitro} diminution of the property with time may be due to absorption by the bacteria rather than to destruction of the property by some other means.

However, the existence of a bactericidal or bacteriostatic property in milk as it comes from the udder, the difference in apparent activity of this property in the milk of different cows as shown by Jones and Little (15), and the indication that the suitability of the environment within the udder would be an important factor in the establishment of an infection (23) suggest that in the bactericidal property of milk might be found some explanation of the nature, if not the cause, of the \textit{age factor}. But whatever the actual mechanism that operates in the infection phase, careful artificial infection experiments help to show that it is in the interior of the mammary gland that a critical point is reached in the establishment of an infection with \textit{Str. agalactiae}. Thus it could be inferred from the experiments of Christiansen and Nielsen (5), Jones and Little (16), and Little (18), that the mere introduction of \textit{Str. agalactiae} into the teat cavity was of much less importance than the conditions and forces met there by the \textit{Str. agalactiae}, and that the conditions or forces met
there could be overwhelmed by mere large numbers of *Str. agalactiae*. The point that has not been considered is that natural *Str. agalactiae* infection probably must be brought about by even smaller numbers of streptococci than were used in such experiments. Thus some moderation of the conditions or forces met in the interior of the udder must occur through which the relative size or effect of the small natural infective dose assumes the proportions of a large artificial infective dose.

There is ample reason to believe, therefore, that the mammary gland in general is not inhabited by *Str. agalactiae* and that the presence of such bacteria sporadically in small number in the secretion during a period of apparent normality does not necessarily indicate an infection. If this be true, then the regularity with which infection occurred in relation to age in the present study indicates a widespread occurrence of *Str. agalactiae* in the immediate external environment of virtually all cows in any group when one or more cows with a *Str. agalactiae* infected udder is present. That such is the case has been clearly demonstrated by the Imperial Bureau of Animal Health (14) study and by the work of others to which it refers. This is also supported indirectly by the observations of those attempting to set up herds free of *Str. agalactiae*. Thus Minett et al. (21), Plastridge et al. (25, 26) and Little (19) have shown that the spread of *Str. agalactiae* to uninfected cows was not stopped until all infected cows were removed from the immediate vicinity of the uninfected ones.

A special instance, in which the presence of an udder infected with *Str. agalactiae* in the ordinary sense (and, therefore, presumably the widespread presence of this organism in the cow’s environment) was precluded, is that reported by Bull et al. (3). These workers established a 30 cow herd on isolated, renovated and disinfected premises from virgin and recently bred heifers. By intensive study of the secretion by cultural methods, *Str. agalactiae* was first isolated from the third cow to calve, six weeks after the lactation started and five months after the animals had been assembled on the premises. *Str. agalactiae* was isolated from the milk of 16 quarters during the first week of the first lactation. Thereafter, *Str. agalactiae* was isolated (by testing every two weeks) from 43 percent of the cows or 25 percent of the quarters on one or more occasions during the first lactation. During the second lactation, isolation was accomplished in 70 percent of the cows or 36 percent of the quarters. Thirteen weeks was the longest the streptococci persisted in the first lactation, and 14 weeks was the longest in the second lactation. In most cases, in either lactation period *Str. agalactiae* could be isolated only once from a particular quarter.

The authors were quite clear in their statement that, to the end of the second lactation period for all of the cows, the characteristic picture of chronic streptococcal mastitis caused by *Str. agalactiae* was not reproduced in the herd. This they attributed to the possible absence of “epidemic strains” of the streptococcus (there appears to be no clear evidence in the literature that such strains exist) and the absence of preliminary damage to the tissues of the udder by other infections because of the youth of the cows. In the light of our knowledge of the age factor, it is not surprising that the characteristic picture of *Str. agalactiae* infection and mastitis was not evidenced in this herd during the first two lactation periods. When the subsequent report on this study appears, dealing with the third and later lacta-
tion periods, there should be provided an interesting illustration of the operation of the *age factor*.

The source of the *Str. agalactiae* in this herd was not found by Bull et al., although an attempt was made which led to the findings of such streptococci in the feces of seven cows and from sores on the teats of two cows. The only conclusion was that the infected udder was not the only reservoir of *Str. agalactiae*. Such certainly appears to have been true in this instance, for even the well-known presence of this organism in the udders of a small percentage of heifers at first freshening would not explain the persistence of *Str. agalactiae* in the herd for so long. Yet this circumstance must be taken as unusual, at least for the time, because of the fact that herds have been freed of *Str. agalactiae* (19–21–25–26) by no more elaborate methods than those used by Bull et al. and have been maintained free of *Str. agalactiae* for a length of time that would not have been possible if there had been some reservoir of this organism other than the infected udder.

As long as the nature of the age factor as it relates to *Str. agalactiae* infection of the bovine udder remains unknown, no direct control over it can be exercised. In herds such as those in which the age factor was studied (24), it would, of course, be possible to limit the duration of each cow's stay in the herd to the first two lactation periods. In this way, the incidence of *Str. agalactiae* infection would be reduced, and could be maintained at, a theoretical zero point. Much this same conclusion could have been made from previous investigations, for, as has already been pointed out (23), one point on which many workers agree is that in *Str. agalactiae* infection there is an increasing-with-age pattern. Yet, we know of no instance in which the control of such infection was attempted in a herd by purposely reducing the age of the herd or by limiting the length of time that animals might remain in a herd. However, this would appear to have been accomplished unconsciously by Torrance (31). As a result of the study of bovine tuberculosis and its relation to age, Torrance suggested that the control of tuberculosis would be facilitated by the raising of all replacement animals and by removal of all animals from the herd at the time of third calving. It was later reported by Francis and Steward (8) that this plan in practice was found also to reduce to a minimum the incidence of clinical mastitis. Although this does not indicate whether streptococcal infection was minimized, and it is realized that streptococci are only one cause of mastitis, nevertheless this probably represents an instance in which the effect of the age factor was indirectly limited. The impracticability of such an approach under the present system of milk production in this country prevents any possibility of its general use in the control of *Str. agalactiae* infection and mastitis.

When it is fully realized that the age factor is an expression of host susceptibility, and that individuals become receptive at different times largely for reasons to be found within the cow, the implications that arise are numerous. Several illustrations of the effect that the age factor might have on the study of udder infection probably will serve better than an attempt to review many works. For example,
Stableforth (29) indicated that *Str. agalactiae* was more prevalent in larger than in smaller herds, Bryan (1) found no clear difference, and Ferguson (6) showed a trend toward a higher incidence of infection in small herds. Obviously, other things being equal, no comparison of the incidence of infection can be of value for such purposes unless proper allowance is made for age.

It has long been a recommendation in various schemes for the control of *Str. agalactiae* infection that all herd replacements be made up of animals calving for the first time. This has been based largely on the knowledge that the occurrence of *Str. agalactiae* infection in such individuals is very low and the practice is, of course, sound. When the removal of infected individuals is deliberate, although not complete at one time, and is combined with segregation of infected cows within the barn and other "precautions," it is not surprising that any decrease in the spread of infection is likely to be attributed largely to such segregation and precautionary measures. The work of Plastridge, Anderson and Weirether (26) appears to offer a good illustration of this. Although the end result (the freeing of herds of *Str. agalactiae*) would not have been accomplished any more quickly by recognition of the age factor, the conclusion of the authors that segregation retards significantly the incidence of new infection is probably not sound because the lowering of the incidence of new infection was made at the same time that the age of the herds was being reduced.

In the study of the role of milking machines vs. hand milking in the spread of *Str. agalactiae* infection, Horwood, Clark and Bryan (10) found less spread when cows were milked by machine, Cone (4) found no significant difference, and Hucker (13) and Hucker and Harrison (12) reported a greater amount of infection in machine-milked cows. Obviously, the conditions under which each herd was maintained would be thought to influence these studies, but unless the age factor is controlled in any two balancing groups, it is impossible to assay properly any difference in results.

This would be true particularly in artificial infection experiments of more than a few months' duration. When such experiments are of short duration, the absence of infection if the experimental animals are of the same age and have been exposed to natural cases would serve to indicate more or less equal status (at least momentarily) with regard to the age factor. But when such experiments employ animals of different age or cover more than a few months, the inability to predict which animals are going to develop susceptibility would seriously affect the reliability of the results.

It is realized that there may be conditions of possible significance other than the age factor, and some of them will be given consideration in a subsequent publication. However, the high degree of correlation between age and *Str. agalactiae* infection (24) relegates all other influences to a subordinate position in the two herds studied, and the almost universal recognition of an increasing-with-age pattern in streptococcal infection makes it virtually certain that this same high correlation is a general rule. If this is so, then it is most unfortunate that it has not been recognized earlier, for, obviously, much of what is now recognized as "known" must be restudied or re-evaluated in the light of the age factor.
REFERENCES


REPORT OF COMMITTEE ON MEAT AND MILK HYGIENE


The magnitude and intensity of World War II was so gigantic that it effected either directly or indirectly practically every individual as well as every phase of human endeavor and activity. Supplying our armed forces, the armies of our allies, and our civilian population with an adequate ration and supply of foods of animal origin is now recognized as one of the outstanding contributions to the support of the war effort.

There were numerous developments in the meat and milk industries due to wartime requirements. The drafting of personnel by selective service boards greatly depleted the forces regularly employed in meat and milk inspection. While the quantity of inspected products increased, the quality of inspection naturally was reduced. Numerous meat plants that operated under local meat inspection service systems were taken over by the Federal inspection service. A goodly number of these plants by making certain adjustments, were able to comply with Federal regulations and as a result are now during the reconversion period continuing to operate under Federal supervision. Many states and cities are planning to increase the number of veterinary inspectors as rapidly as they become available. With an expanded program will come a call for an additional number of veterinarians. Well trained men are needed to cope with the problems of reconversion which are numerous as well as complex.

The Federal system of meat inspection has once again demonstrated its ability to successfully overcome the added burdens of a greatly increased demand for food, an accomplishment of which we are very proud. The military meat inspection forces were able to carry on their stupendous task of safeguarding the meat supply of our armed forces and the forces of the allied armies with a record unequalled in history. The military milk inspection service not only corrected many abuses but brought about great improvements in many milk plants, which was an accomplishment of tremendous importance. The inspection of poultry made important advances and extension of this type of service was a remarkable achievement. Both meat and milk inspection services by the states and cities were maintained at almost a normal standard of service. The above enumerated accomplishments constitute remarkable contributions by those engaged in Meat and Milk Hygiene during World War II. The inspection of poultry appears to be destined to soon become one of the leading inspection services of the nation. This service is of prime importance for the protection of public health and should get unlimited support. The major part of this work is performed by veterinarians and the demand for more veterinarians is greater than can be supplied in the near future.

The slogan “Food Will Win the Peace” is as appropriate at the present as was the slogan “Food Will Win the War” when the country was engaged in actual warfare.

128
A plentiful supply of good food did aid materially in winning the war. It not only prevented starvation, it kept the soldiers in splendid physical condition which always plays a big part in maintaining morale. Had there been a let down in either quantity or quality, sickness and malnutrition might have seriously prolonged the period of the war. Most of our allies were so concerned with the fighting close at home they had little time left to even attempt to produce their own food supplies. That meant that America had to supply practically all the food for the entire allied forces. In an attempt to win the peace we busily engaged in feeding the people of the war devastated countries. This is indeed important.

Unquestionably, the wartime Army milk procurement and inspection program has made a beneficial and, it is hoped, a lasting impression on the nation's milk supply and milk inspection service.

Wartime needs were productive of many new developments in the milk industry and in the inspection of milk. Among the most noteworthy of these was the "three to one concentrated milk." This procedure permitted the armed forces to secure milk from areas when it was plentiful and after same had been reconstituted, shipped to areas where milk was very scarce. The demands for fresh milk on hospital ships led to the use of a frozen, pasteurized, homogenized product. This product proved to be as palatable and desirable as the fresh product. The widespread utilization of the phosphatase test as a tool in determining the efficiency of pasteurization processes in milk producing plants was a definite step forward. Another new development consisted of the wider application of the coliform test. As a result, the interpretation and importance of this test as well as the significance of coliform organisms in milk is more clearly understood. Methods or techniques used in conducting the coliform test are efficient diagnostic procedures. The organoleptic test brought forth interesting discoveries, particularly as related to the detection of high acidity of milk when shipped long distances under dry ice refrigeration.

Judging from these observations and findings, it was quite evident that in order that our nation can continue to provide our armed forces with pure wholesome milk of high quality, we must continue to improve our inspection services.
THE EFFECT OF FORM VARIATION ON THE ANTIGENIC BEHAVIOR OF S. PULLORUM

By P. R. Edwards, Ph.D., and D. W. Bruner, D.V.M.

Department of Animal Pathology, Kentucky Agricultural Experiment Station, Lexington, Kentucky

Since Salmonella pullorum is a non-motile and non-flagellated organism its serological reactions are due entirely to somatic antigens. Further, it is not known to contain heat labile components. Hence, in any investigation of variability of its antigenic behavior it is necessary to consider only those phenomena of bacterial variation which affect heat stable (O) antigens. In the Salmonella group the only variations in which O antigens are involved are the smooth-rough variation of Arkwright and the form variation of Kauffmann. Since the X strains of the Canadian investigators occur among recently isolated cultures it is logical to assume that smooth-rough variation plays no part in the production of these variants. This suggests that an explanation of the occurrence of X strains might be found in form variation.

Form variation was discovered by Kauffmann (1) in a study of the variable cross agglutination which occurred between the different O groups of the genus Salmonella. He found that the amount of antigen I, which occurs in groups A, B, D and E varied markedly in different colonies of certain types which contained that antigen. Colonies which contained large amounts were called I++, those which contained small amounts I±.

Each form tended to breed true but eventually reverted to the mixed state found in the parent culture. The discovery of this variation explained why some cultures of a given type within group B agglutinated actively with S. paratyphi A serum (I,II,III) while other cultures of the same type were affected little, if at all, by this serum.

Later Almon and Stovall (2) described a culture of S. typhi (T2) which they concluded lacked antigen IX, the major O antigen of the typhoid bacillus. In the study of this strain Kauffmann (3) found that it did not lack antigen IX but that a portion of antigen XII, a common antigen of groups A, B and D, was missing. In addition it was found that XII was divisible into three parts which were designated as XII1, XII2 and XII3. Normal cultures of S. typhi contained all three components while T2 contained only XII1 and XII2. In many types XII2 was variable in the same way as antigen I, mentioned above. S. paratyphi A contained XII1 and XII2, while S. paratyphi B, S. typhi-murium and S. reading contained XII1 and XII2.

Younie (4) reported the occurrence of S. pullorum in chicks derived from flocks which contained no reactors to agglutination tests in which standard strains of S.

1 The investigation reported in the paper is in connection with a project of the Kentucky Agricultural Experiment Station and is published by permission of the Director. It was supported in part by a research grant from the U. S. Public Health Service.

130
pullorum were used as antigen. When chicks were exposed to infection with cultures from such flocks they rapidly produced agglutinins for the infecting strains but not for the standard antigen strains. Younie concluded that antigenic differences existed between the standard strains and the cultures which he isolated from chicks.

The observations of Younie were confirmed and extended by Byrne (5), Wright (6, 7), Gwatkin (8, 9, 10) and Gwatkin and Bond (11). From the work of these investigators it became apparent that there were strains of S. pullorum in Canadian flocks which were antigenically different from the standard antigen strains and that these "variant" or "X" strains did not always produce agglutinins in infected birds which were detectable by the standard agglutination test. The nature of these differences has been variously described by different workers and is not well understood. Since S. pullorum, like S. typhi, has O antigens IX, XII it seemed logical to search for variation in antigen XII as the cause of these differences. The

<table>
<thead>
<tr>
<th>Table 1.—Agglutination tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Pullorum St................</td>
</tr>
<tr>
<td>Pullorum X..................</td>
</tr>
<tr>
<td>Typhi T 2...................</td>
</tr>
<tr>
<td>Typhi 0901..................</td>
</tr>
<tr>
<td>Durazzo......................</td>
</tr>
<tr>
<td>Reading.....................</td>
</tr>
<tr>
<td>Pullorum Na................</td>
</tr>
<tr>
<td>Pullorum Nb................</td>
</tr>
</tbody>
</table>

Figures indicate highest dilution at which agglutination occurred 0 indicates no agglutination at 1-100.

present paper sets forth the results obtained in serologic studies of standard and variant strains and includes comments regarding these results.

MATERIALS AND METHODS

Cultures of standard and variant strains (hereinafter called St and X respectively) were generously furnished by Mr. M. L. Wright and Dr. Ronald Gwatkin. Dr. Gwatkin also sent a sample of Proteus antiserum which agglutinated X strains but not St strains. Agglutinating serums were prepared by injecting rabbits with boiled cultures of the two forms of S. pullorum, with S. typhi 901 (IX, XII, XII, XII), S. typhi T2 of Almon and Stovall (IX, XII, XII), S. paratyphi A var. durazzo (II, XII, XII) and the XII + + form of S. reading (IV, XII, XII). These serums were used in agglutination and absorption tests the results of which are given in Tables 1 and 2. A number of cultures isolated in Kentucky in 1946 were included in the study.

The agglutination tests indicated that standard strains of S. pullorum resemble S. typhi T2 while the X strains resemble S. typhi 901. It is also evident that S. pullorum St and S. typhi T2 are strongly related to S. paratyphi A var. durazzo
while the X strains and S. typhi 901 are more closely allied to S. reading. The Proteus serum gave reactions almost identical with those obtained with S. reading serum. These reactions indicate that S. pullorum St contains XII, and XII.

### Table 2.—Absorption tests

<table>
<thead>
<tr>
<th>SERUMS</th>
<th>ANTIGENS</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pullorum St</td>
<td>Pullorum X</td>
<td>Typhi T2</td>
<td>Typhi 901</td>
<td>Reading</td>
<td>Durazzo</td>
</tr>
<tr>
<td>Pullorum St</td>
<td>Absorbed by</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pullorum X</td>
<td>200</td>
<td>0</td>
<td>200</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Typhi T2</td>
<td>0</td>
<td>400</td>
<td>0</td>
<td>400</td>
<td>400</td>
<td>0</td>
</tr>
<tr>
<td>Typhi 901</td>
<td>200</td>
<td>0</td>
<td>200</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pullorum X</td>
<td>Absorbed by</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pullorum St</td>
<td>0</td>
<td>200</td>
<td>0</td>
<td>400</td>
<td>200</td>
<td>0</td>
</tr>
<tr>
<td>Typhi T2</td>
<td>0</td>
<td>3200</td>
<td>0</td>
<td>3200</td>
<td>1600</td>
<td>0</td>
</tr>
<tr>
<td>Typhi 901</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Typhi T2</td>
<td>Absorbed by</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pullorum St</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pullorum X</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>Typhi 901</td>
<td>50</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>Typhi 901</td>
<td>Absorbed by</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pullorum St</td>
<td>0</td>
<td>200</td>
<td>0</td>
<td>400</td>
<td>200</td>
<td>0</td>
</tr>
<tr>
<td>Pullorum X</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Typhi T2</td>
<td>0</td>
<td>3200</td>
<td>0</td>
<td>3200</td>
<td>1600</td>
<td>0</td>
</tr>
<tr>
<td>Durazzo</td>
<td>Absorbed by</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td>400</td>
<td>100</td>
<td>200</td>
<td>200</td>
<td>0</td>
<td>1600</td>
</tr>
<tr>
<td>Reading</td>
<td>Absorbed by</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Durazzo</td>
<td>0</td>
<td>800</td>
<td>0</td>
<td>1600</td>
<td>1600</td>
<td>0</td>
</tr>
</tbody>
</table>

Figures indicate highest dilution at which agglutination occurred. 0 indicates no agglutination at 1-50.

while the X strains contain XII, and XII and perhaps XII. The Proteus serum of Gwatkin contains a strong XII agglutinin.

In absorption tests S. pullorum St and S. typhi T2 proved mutually absorptive, indicating their close relationship. Likewise, S. pullorum X and S. typhi 901 each removed all agglutinins from the serum of the other and probably have identical O
antigens. When S. typhi 901 serum or S. pullorum X serum was absorbed with S. typhi T2 a strong residue of agglutinins remained for S. typhi 901, S. pullorum X and S. reading. This residue represented the antigen XIIa. When the serums were absorbed with S. pullorum St only a very weak fraction remained in the serum. This indicated that S. pullorum St contained a sufficient amount of XIIa to absorb most of that agglutinin although it did not possess a sufficient amount of the antigen to be agglutinated by XIIa serum. This conclusion is supported by the absorption of S. pullorum St serum by S. typhi T2. As stated above, this absorption removed all agglutinins for the serum strain but left a well defined agglutinin titre for S. pullorum X, S. typhi 901 and S. reading. Apparently, S. pullorum St did not contain sufficient XIIa to be affected by agglutinins for that antigen but it did contain a sufficient amount to produce a low titre of agglutinins for XIIa. S. typhi T2, being practically devoid of XIIa antigen, failed to remove agglutinins for that fraction. Thus, there occurred the unusual situation of an absorbed serum failing to agglutinate the culture from which it was derived but still agglutinating other cultures.

Durazzo serum (II,XIIa,XIIa) absorbed by S. reading (IV,XIIa,XIIa) still agglutinated S. pullorum X in low dilution, indicating that the variant strains contained a small amount of XIIa. S. reading serum absorbed by Durazzo no longer agglutinated S. pullorum St, again indicating that the standard strain did not contain sufficient XIIa antigen to be affected by agglutinins for that component. In the same serum S. pullorum X was strongly agglutinated, again proving the presence of a strong XIIa factor in the variants.

It can only be concluded that the antigenic formula of S. pullorum is IX,XIIa, [XIIa], XIIa, the brackets indicating that XIIa is a variable antigen. The XIIa± and XIIa++ forms were easily distinguished in slide agglutination tests using S. reading serum absorbed by Durazzo (XIIa) and Durazzo serum absorbed by S. Reading (XIIa). The ++ forms agglutinated rapidly and strongly in XIIa serum but only slowly and weakly in XIIa serum. In the ± forms these reactions were reversed. A culture which contained a ± component of XIIa possessed a strong XIIa component. Conversely, a culture which contained a large amount of XIIa had only a minimal amount of XIIa. This accounted for the marked effect of the variation on the agglutinative behavior of the cultures. It also probably accounted for the failure of S. pullorum X and S. typhi 901 to remove all the XIIa agglutinins from serums that contained large amounts of that substance.

The stability of the standard and variant strains used above was determined by plating the cultures and examining 100 colonies of each type by slide agglutination with XIIa and XIIa serums. The standard strains yielded only XIIa± colonies, while only XIIa++ colonies were found in variant cultures. This indicated that the cultures used in the serological analysis were quite well stabilized in their respective forms. Certain cultures recently isolated in this laboratory gave quite different results. Both XIIa± and XIIa++ colonies could be found in cultures repeatedly reisolated from single colonies. When the ± and ++ forms were carried as stock cultures each eventually was proved to contain the other form. These variable cultures which contain a full complement of the antigens of the species are considered to be the normal form of S. pullorum (S. pullorum N). The reactions of two
forms obtained by plating a single colony strain of *S. pullorum* N are included in table 1 (Na and Nb).

This variation was found in old laboratory strains as well as in recently isolated cultures. Strain 17, long used as antigen in many laboratories, contained a few XII± + + forms, although the majority of the colonies were of the XII± ± variety. This was true of three cultures of the strain maintained in different laboratories for a period of years.

From the above it would seem that *S. pullorum* is subject to form variation which involves antigen XII. In normal cultures this variation occurs continuously, so that XII± ± and XII± + + forms can be isolated from the same strain. In some instances the organism becomes well stabilized in the ± or + + form, thus giving rise to "standard" or "variant" strains. According to this view the variant or X strains of *S. pullorum* are not a special strain but can arise from any culture by stabilization in the + + form. The wide geographic distribution of X strains reported by Wright (7) supports this view as does experience in this laboratory, where it has been found that X strains and normal strains were sometimes present in the same lot of chicks. Further, approximately one third of the cultures of *S. pullorum* isolated in Kentucky in 1946 were classified as X strains. These were not confined to chicks from any particular hatchery, but were widely distributed.

The comments in the preceding paragraph should not be interpreted to mean that a given strain may not become stabilized in the XII+ + + form and, through its failure to produce agglutinins detectable by standard antigen, become very widely distributed while ordinary strains are being eliminated through systematic testing. This is obviously what has happened in certain flocks studied by Canadian workers. Such circumstances give rise to pure variant infections.

The repeated isolation of X strains from the chicks of flocks which contained no reactors to standard antigen and the work of Gwatkin and his associates on artificially infected fowls naturally raise the question of antigens to be used in testing for pullorum disease. Some laboratories have used two antigens, thus doubling the work to be done. Other laboratories have used antigens made from a mixture of standard and variant strains. According to some reports the mixed antigens are not so efficient as the standard and variant strains used separately. In addition, some workers have reported that a certain number of nonspecific reactions are obtained with variant antigens. Therefore, it seems desirable to seek another solution to the problem.

Not being engaged in pullorum disease control the writers are rather reluctant to make suggestions concerning the antigen problem. Nevertheless, certain observations call for comment. It seems that the greatest shortcoming of the strains 17, 19 and 20 is a relative insensitivity to agglutinins for antigen XII, particularly XII±, when compared with recently isolated strains. It is suggested that search may reveal cultures so balanced between the XII± ± and XII± + + forms that they would react well with both XII± and XII+ agglutinins. In addition the cultures must possess the other necessary attributes of a good diagnostic antigen. It would seem well worth while to search for one or more cultures which would agglutinate with the serum of all birds infected with *S. pullorum*. Until more suitable antigen cultures are found or until it is evident that the problem of variant infection in the
ANTIGENIC BEHAVIOR OF S. PULLORUM

United States requires immediate action, it is suggested that one or more of the standard antigen strains remain in continued use.

SUMMARY

The antigenic formula of *S. pullorum* is IX, XII, [XII₂], XII₄. In normal cultures the XII₂ factor is variable and forms containing a large amount or a negligible amount of XII₄ can be isolated from the same strain. Apparently, cultures may become stabilized in either form thus giving rise to "standard" strains and "variant" or X strains. The standard strains contain a small amount of XII₄ while the variant strains contain a large amount of the antigen. Certain observations were made concerning antigens to be used in testing for pullorum disease.

REFERENCES

3. Ibid., 41: 127, 1940.
5. Ibid., 7: 227, 1943.
7. Personal communication.
DISCUSSION

BY RONALD GWATKIN, D.V.M.

Division of Animal Pathology, Animal Diseases Research Institute, Hull, Quebec

I deeply appreciate the opportunity of discussing the very important paper by Drs. Edwards and Bruner to which we have just listened. It is encouraging to Canadian workers to receive this confirmation of their work, and I feel that this paper will take its place with the historical ones in Pullorum Disease literature, among which must certainly be included those of Younie, who first drew attention to this difference in antigenicity in 1941.

The question of regular and variant forms of *S. pullorum* is no academic one! It had become a very real threat to our poultry industry before it was realized that the antigen we were using was failing to detect birds infected with variant type *S. pullorum* and, as a result, severe losses were occurring in chicks hatched from eggs from apparently clean flocks.

We have examined 136 cultures of *S. pullorum* and found them, like the strains used in this antigenic analysis, to be quite stable. Thirty-eight were of the Younie and 98 of the standard type. Fifty colonies each were examined from platings of 64 cultures, and in the variant types we did not encounter a single colony that was not agglutinated by variant and Proteus serum. In the standard cultures we did find up to 10 per cent of colonies that would show a fine breaking up with these two sera and which gave clear cut reactions with regular serum. When these colonies were subcultured the picture remained the same—a few colonies that broke up slowly and gave only a very fine reaction. As tube antigen, and by the slide method, such cultures produced a clear-cut regular antigen. None of these strains would have met the requirements suggested by Edwards and Bruner, that is, none were so balanced that they would have been capable of detecting birds infected with either regular or variant forms. This should not be construed as suggesting that such balanced strains can not be isolated, because in this paper Edwards and Bruner record that they have repeatedly isolated XII*++* forms from single colonies. None of the strains we examined were primary isolations, having been subcultured one or more times before we received them. We have not been able to find any differences between the two forms except in their antigenicity.

I am in complete agreement with the idea that, by the consistent use of an antigen lacking in XII*, we assiduously removed all the standard type infected birds and missed the others, as a result of which we built up a great reservoir of the variant or Younie type of infection, which has now been reduced by the use of a more suitable antigen. Two lessons we should have learned from this painful experience are, that we should never regard the antigen question as a settled one; and that we should examine a proportion of strains isolated from chicks every year as a routine pro-
DISCUSSION

procedure, to determine whether the antigenicity of such strains is in line with the antigen in use.

We found it necessary to use two antigens in the tube test because the efficiency of a mixed tube antigen, prepared from variant and regular forms, fell too far below the results obtained by using both these types as separate antigens. However, our results showed that if only one antigen could be used it would be better to use the mixed one than either of the others alone.

A mixed whole blood stained antigen prepared according to the K formula of the B.A.I., gave practically as good results as the separate use of variant and regular whole blood antigens. There is a somewhat greater tendency to a non-specific breaking up when variant antigens are used either separately or incorporated in a mixed antigen, but this has been largely avoided by reading the whole blood test in 30 seconds, and variant tube antigen at 24 hours. At present it is more troublesome in the tube test, but I hasten to add that the regular tube antigen prepared from Strains 17, 19 and 20 has apparently given its share of trouble in this regard.

We have never considered our antigen problem as settled, and have tried a great number of modifications to get away from this difficulty, so far without results. If it is possible to obtain a culture which has a proper balance of the necessary factors, as suggested by Edwards and Bruner, this would appear to be the most promising solution of the problem. We attempted to reach this goal by growing the two types in symbiosis but ended up with a predominantly variant type antigen.

Some 3½ million doses of stained whole blood antigen containing the regular and Younie types in equal proportions were used with apparently very satisfactory results last year, as judged by chick mortality during the past season, and by the low percentage of reactors encountered this season in those areas of which we have knowledge. I am unable to give figures on the amount of tube antigen used, as a large amount of this was made by other laboratories. The whole blood antigen is made under our supervision by the Connaught Medical Research Laboratories, Toronto, and anyone desiring to obtain it for trial must make application to the B.A.I. for a permit to import it. In those provinces from which we have comparative figures on the recovery of S. pullorum, it is interesting to note the reduction since the use of variant antigen was commenced, either by the tube method, or as a mixed antigen in the whole blood test. These figures of course only represent the results on chicks received by these laboratories for examination. In Manitoba the recovery of S. pullorum in 1945 was only 4.1 percent of what it was in 1944. In Ontario, the recovery of this organism in 1945 was 50 percent of what it was in 1944, and the 1946 figure was again half that of 1945. In Prince Edward Island, the recovery of S. pullorum from chicks in 1945 was only 25 percent of that in 1944, and in 1946 the organism was not recovered from any of the chicks examined. In Nova Scotia, the recovery from chicks in 1946 was only 9.5 percent of that of the previous year. In the last two provinces, tube testing only is employed.

The presence of the XII fraction in sufficient quantity to produce agglutinins or to absorb them, but in insufficient amount to be agglutinated, explains some of our puzzling results in absorption tests and in endeavours to produce regular type serum free from the heterologous agglutinins.
I am unable to discuss the situation in the United States, but I do know that Wright has identified the Younie form in cultures from the States, as we have done, and now we learn that one-third of the cultures isolated in Kentucky in 1946 were classified as of this type. We learned our lesson the hard way and it seems to me that a great deal of trouble might be avoided by making sure that the same condition is not building up in the United States.

Thank you, Mr. Chairman, for the opportunity of saying something in connection with this important contribution to the pullorum disease literature.
STUDIES ON THE CONTROL OF FOWL TYPHOID

BY W. J. HALL, D.V.M., A. D. MACDONALD, D.V.M., AND
D. H. LEGENHAUSEN, D.V.M.

Pathological Division, Bureau of Animal Industry, Agricultural Research
Administration, U. S. Department of Agriculture

Fowl typhoid, an acute, infectious disease of chickens and other domesticated
poultry, is widespread in this country, Europe, Africa, and South America. Chick-
ens, turkeys, guinea fowls, and some wild fowls are susceptible, but ducks, geese,
and pigeons are reported to be resistant. The early history of the disease in foreign
countries has been reviewed by Beaudette (3) and Lesbouyries (12). The disease
was first recognized in this country about 50 years ago, when it was called "infect-
ious leukemia" in 1895 by Moore (16). In 1902 Theobald Smith, working with
Cooper Curtice (6) in Rhode Island, suggested the name "fowl typhoid" on account
of its similarity to human typhoid. Since the publication of the work of these
early investigators, little research has been done on this disease in this country
other than the comprehensive investigations of Kaupp and Dearstyne in 1925 (10),
Gauger in 1937 (8) and Van Es and Olney in 1940 (20).

OCCURRENCE

On the basis of a nationwide survey recently made by questionnaire by Moore
(15), fowl typhoid at the present time is most prevalent along the southern Atlantic
seaboard. In 9 Atlantic seaboard States from New Jersey to Alabama, the average
number of fowl typhoid outbreaks in the past year was 86, while in the remaining
31 States reporting, it was 7. To the question as to whether fowl typhoid had
increased during the past 5 years, 19 States reported "Yes" and 27 "No."

Fowl typhoid has greatly increased in frequency, virulence, and extent along the
eastern seaboard during the last decade so that it is now one of the greatest disease
hazards to profitable poultry raising in that area.

During the early days when poultry raising was confined to small farm flocks,
fowl typhoid was not a serious economic problem as the losses could be controlled
by culling, cleaning up, and replacement. Since the advent of poultry raising on a
mammoth scale, particularly in some broiler raising areas, losses from fowl typhoid
have become alarming not only in the crowded broiler houses but on the breeding
ranges and in the laying houses. Poultrymen tried desperately to control losses
by the old recommended methods of rigid culling of all sick and exposed birds,
following by thorough cleaning and disinfection, but to little avail. Losses continued
unabated year after year. It was evident to poultrymen and disease control
authorities alike that there was insufficient knowledge of the principal means of
dissemination of this disease. For these reasons, the Bureau was requested to
undertake research work on methods of transmission and control. In this work the
Bureau was greatly aided by the generous cooperation of the industry and State
regulatory officials of Delaware.
Fowls of all ages are affected from baby chicks to breeding stock, and the disease occurs with about equal frequency in young and mature stock. Losses vary in different outbreaks from an occasional bird, especially in old breeding flocks, to 75 percent or more in young chickens. Fowl typhoid is seen more frequently in warm weather, most acute outbreaks occurring in young birds between April and November along the eastern seaboard. However, in some laying flocks losses continue throughout the year with some abatement in winter.

**Lesions and Diagnosis**

In acute cases the usual picture is swelling and redness of the liver, spleen, and kidneys in both baby chicks and adults. The liver is sometimes of a light brick red color and mottled with yellow streaks. Flaccid and ruptured ova are a frequent complication. In peracute cases no changes may be noted in the viscera. The greenish bronze or mahogany liver and nodules in the myocardium are seen usually in the more chronic cases. *Shigella gallinarum* may be readily isolated from any of the organs or excretions of the body of a bird dead of the disease. Thus in the acute stages of the disease the sick bird is disseminating the causative organism of the disease from both the mouth and intestinal discharges.

**Means of Transmission**

Kaupp and Dearstyne (10) in 1925 concluded from their experimental work that 1) the means of dissemination from flocks to flocks is through infected soil on common range grounds, by surface washing, and through conveyors, such as man and animals; 2) in the flock the disease is spread through contaminated soil, food, and drinking water, and through eating the blood of infected birds dying of the disease; and 3) the carrier of fowl typhoid is a flock menace. In 1937 Gauger (8) found the organism of fowl typhoid to be present in the droppings and in the eye and mouth discharges of birds in the febrile stage of the disease, and he found that it may persist for months in the nasopharynx, thus contaminating the drinking water and possibly the feed. He cultured 626 eggs of carriers but recovered *Sh. gallinarum* from only 3 eggs, and concluded that chances of perpetuation of the disease from this source under field conditions are remote, because no outbreak in baby chicks had been recorded in the State in 15 years in spite of high incidence of the disease in adults.

Van Es and Olney (20) concluded from their experiments on the effect of environment on the dissemination of fowl typhoid that sanitary measures have a very favorable influence on the prevention of the disease. Of 80 exposed fowls dying of fowl typhoid 10 were lost in a clean pen and 70 in an unsanitary pen.

Manninger (13) states that female carriers play the most important role as *B. gallinarum* occurs more or less frequently in the ova of hens that suffered from the disease as baby chicks.

In 1925 Beaudette (2) reported the isolation of *B. gallinarum* from the heart blood of chicks 1 to 3 weeks old, from the ovary of an adult hen, and also from the unabsorbed yolk of a dead embryo. About ½ of the outbreaks of fowl typhoid occurred in young chicks the histories of which indicated egg origin, although it was suggested that some may have originated by contact with adults or contaminated...
CONTROL OF FOWL TYPHOID

environment. Later that writer (4) stated that fowl typhoid is transmitted through the egg.

Doyle (7) cultured 140 eggs from fowl typhoid carriers but failed to recover the causative organism. This he concluded strongly supports the view that infection through the egg is not the natural method of transmission, but since the ovary is the predilection site of the organism in the carrier, it is quite possible that eggs may be occasionally infected.

Beach and Davis (1) in 1927 reported on an outbreak of fowl typhoid in 145 baby chicks, 54 percent of which died within 3 weeks after hatching, although there was no exposure subsequent to hatching. No evidence of contact with the disease after hatching was found so it was concluded that infection came through the egg. Of the parent flock, 32, or 16 percent, reacted to the agglutination test and from the ovaries of 29 Shigella gallinarum was isolated.

Komarov (11) cites two outbreaks of fowl typhoid in baby chicks in which the evidence strongly suggests egg transmission.

EGG TRANSMISSION EXPERIMENTS

To determine the relative importance of the various means by which fowl typhoid may be spread and perpetuated, several experiments in egg and contact transmission of fowl typhoid have been carried out at the Animal Disease Station. In the egg transmission experiments over 5,000 embryonated, infertile, and fresh eggs from typhoid reactors have been cultured over a period of 20 months. About 3,500 of these eggs have come from trapnest fowl typhoid reactors. The typhoid reactors consist of two groups, Pen 20A, 37 naturally infected birds, and Pen 19A, 25 artificially infected birds.

All unhatched eggs, as well as all chicks that died, were cultured. All eggs were washed in a solution of 1 part of mercuric chloride and 1,000 parts of alcohol before being broken out into sterile Petri dishes and were cultured by streaking several loopfuls of yolk and albumin onto large plain agar slants. By the use of sterile rubber gloves in breaking eggs extraneous contamination was kept to a minimum.

The 30 settings from Pen 20A were handled as follows: 8 were incubated for 15 days; 9 completed incubation; and 13 were divided, one half was cultured after 15 days incubation and the other half allowed to complete incubation.

Of the 18 settings from Pen 19A, incubation was interrupted after 15 days in 9; completed in 2; and 7 settings were divided, one half being cultured after 15 days' incubation and the other half allowed to complete incubation. After the 18 settings 10 lots of eggs were cultured when fresh.

The results obtained from the culture of the eggs and chicks from the two groups of reactors are shown in Tables 1 and 2, naturally-infected and artificially-infected reactors, respectively.

From Table 1 it will be noted that 12 out of 37 reactors (32.4 percent) laid infected eggs over a period of 6 months. Of 588 eggs laid by these carriers 33, or 5.6 percent, were infected, and these were scattered through 16 out of 30 hatches. The percentage of infected eggs laid by these carriers varied from 1.1 to 24.4 percent. While most of the reactor hens which transmitted typhoid through their eggs laid only 1 or 2 infected eggs, one laid 11 infected eggs distributed over 9 hatches, and another laid 6 infected eggs distributed over 5 hatches. The hatches
TABLE 1.—Eggs laid by naturally infected typhoid reactors (Pen 20A) which transmitted the disease through their eggs over a period of 6 months

<table>
<thead>
<tr>
<th>AGGLUTINATION TITER</th>
<th>HEN NO.</th>
<th>TOTAL EGGS Laid</th>
<th>INFECTED EGGS</th>
<th>NO. OF HATCHES IN WHICH INFECTED EGGS WERE LAID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Number</td>
<td>Percent</td>
</tr>
<tr>
<td>4</td>
<td>23</td>
<td>102</td>
<td>5</td>
<td>4.9</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
<td>13</td>
<td>2</td>
<td>15.4</td>
</tr>
<tr>
<td>1</td>
<td>29</td>
<td>62</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td>4</td>
<td>31</td>
<td>49</td>
<td>6</td>
<td>12.2</td>
</tr>
<tr>
<td>4</td>
<td>32</td>
<td>45</td>
<td>11</td>
<td>24.4</td>
</tr>
<tr>
<td>3</td>
<td>36</td>
<td>52</td>
<td>1</td>
<td>1.9</td>
</tr>
<tr>
<td>3</td>
<td>41</td>
<td>6</td>
<td>1</td>
<td>16.6</td>
</tr>
<tr>
<td>3</td>
<td>42</td>
<td>19</td>
<td>1</td>
<td>5.5</td>
</tr>
<tr>
<td>3</td>
<td>44</td>
<td>61</td>
<td>2</td>
<td>3.2</td>
</tr>
<tr>
<td>4</td>
<td>57</td>
<td>39</td>
<td>1</td>
<td>2.5</td>
</tr>
<tr>
<td>4</td>
<td>58</td>
<td>53</td>
<td>1</td>
<td>1.9</td>
</tr>
<tr>
<td>1</td>
<td>59</td>
<td>87</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>588</td>
<td>33</td>
<td>5.6</td>
</tr>
</tbody>
</table>

* Rapid whole blood plate test.

TABLE 2.—Eggs laid by artificially infected typhoid reactors (Pen 19A) which transmitted the disease through their eggs over a period of 6 months

<table>
<thead>
<tr>
<th>AGGLUTINATION TITER</th>
<th>HEN NO.</th>
<th>TOTAL EGGS Laid</th>
<th>INFECTED EGGS</th>
<th>NO. OF HATCHES IN WHICH INFECTED EGGS WERE LAID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Number</td>
<td>Percent</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>110</td>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>94</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>11</td>
<td>12</td>
<td>1</td>
<td>8.3</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td>13</td>
<td>3</td>
<td>23.0</td>
</tr>
<tr>
<td>4</td>
<td>19</td>
<td>63</td>
<td>11</td>
<td>17.4</td>
</tr>
<tr>
<td>4</td>
<td>64</td>
<td>40</td>
<td>2</td>
<td>5.0</td>
</tr>
<tr>
<td>4</td>
<td>65</td>
<td>60</td>
<td>5</td>
<td>8.3</td>
</tr>
<tr>
<td>4</td>
<td>67</td>
<td>6</td>
<td>2</td>
<td>33.3</td>
</tr>
<tr>
<td>4</td>
<td>68</td>
<td>30</td>
<td>4</td>
<td>13.3</td>
</tr>
<tr>
<td>3</td>
<td>69</td>
<td>38</td>
<td>1</td>
<td>2.6</td>
</tr>
<tr>
<td>4</td>
<td>71</td>
<td>50</td>
<td>1</td>
<td>2.0</td>
</tr>
<tr>
<td>4</td>
<td>72</td>
<td>28</td>
<td>1</td>
<td>3.5</td>
</tr>
<tr>
<td>4</td>
<td>75</td>
<td>19</td>
<td>1</td>
<td>5.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>563</td>
<td>34</td>
<td>6.0</td>
</tr>
</tbody>
</table>

* Rapid whole blood plate test.

were a week apart. From column 1, it may be seen that the agglutination titer of these carriers was very high\(^1\) in 10 out of 12 hens. Two carriers, however, had a

\(^1\) The rapid whole blood agglutination reactions are graded on a 1, 2, 3, 4 basis as follows: 1 = trace, 2 = incomplete, 3 = slow positive, 4 = rapid positive.
### Table 3.—Results of typhoid infected egg feeding trials

<table>
<thead>
<tr>
<th>BIRD NO.</th>
<th>DATE OF DEATH</th>
<th>DAYS AFTER EXPOSURE</th>
<th>CAUSE OF DEATH</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1, 6 months old (1 egg fed 4–12–46)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3383</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3384</td>
<td>4–18</td>
<td>6</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>3386</td>
<td>4–15</td>
<td></td>
<td>Peritonitis</td>
</tr>
<tr>
<td>3387</td>
<td>4–15</td>
<td></td>
<td>Visceral gout</td>
</tr>
<tr>
<td>3388</td>
<td>5–4</td>
<td>22</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td><strong>Group 2, yearlings (3 eggs fed 5–3–46) (2 eggs fed 5–6–46)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1804</td>
<td>5–9</td>
<td>6</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>1694</td>
<td>5–11</td>
<td>8</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>1840</td>
<td>5–9</td>
<td>6</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>3343</td>
<td>5–13</td>
<td>10</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td><strong>Group 3, yearlings (2 eggs fed 5–10–46) (2 eggs fed 5–14–46)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1915</td>
<td>5–16</td>
<td>6</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>1809</td>
<td>5–17</td>
<td>7</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>1688</td>
<td>5–18</td>
<td>8</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>2390</td>
<td>5–15</td>
<td>5</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>1781</td>
<td>5–19</td>
<td>9</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>3399</td>
<td>5–18</td>
<td>8</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td><strong>Group 4, 8 weeks old (2 eggs fed 5–17–46)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3215</td>
<td>5–28</td>
<td>11</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>2891</td>
<td>5–26</td>
<td>9</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>3251</td>
<td>5–29</td>
<td>12</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>2850</td>
<td>5–26</td>
<td>9</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td><strong>Group 5, 14 weeks old (typhoid reactor progeny) (1 egg fed 6–10–46)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3111</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3104</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3118</td>
<td>6–25</td>
<td>15</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>3141</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Group 6, 13 weeks old (1 egg fed 6–27–46)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3342</td>
<td>7–8</td>
<td>11</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>3561</td>
<td>7–3</td>
<td>6</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>3471</td>
<td>7–6</td>
<td>9</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>3303</td>
<td>7–7</td>
<td>10</td>
<td>Fowl typhoid</td>
</tr>
</tbody>
</table>

very low titer indicating that in removing reactors by the whole-blood, rapid, agglutination method all birds should be discarded, however slight the reaction, since such reactors are potential carriers.

In Table 2, showing eggs laid by artificially infected reactors, the results are
similar to those in Table 1. In this group 13 out of 25 reactors, 52 percent, laid infected eggs over a period of 6 months. Of 563 eggs laid by carrier birds in Pen 19A, 34, or 6 percent were infected. The percentage of infected eggs laid by these carriers varied from 0.9 percent to 33.3 percent. One bird, No. 19, was an outstanding carrier, producing 11 infected eggs scattered over 9 hatches. Another bird, No. 65, produced 5 infected eggs in 5 different hatches.

Shigella gallinarum was also recovered from fresh eggs but not to the extent that it was in the incubated lots. Of the 18 incubated settings from Pen 19A Sh. gallinarum was recovered from 14, while from the 10 lots of fresh eggs from this same pen Sh. gallinarum was recovered from 5. This may have been due in part to a natural seasonal slackening in the rate of lay. However, 3 eggs which were sterile when cultured fresh yielded Sh. gallinarum when cultured again after incubation for 24 to 48 hours.

That these infected eggs laid by typhoid carriers may be the means of starting new outbreaks of typhoid in laying flocks is indicated by the results of the egg feeding trials shown in Table 3. Of six groups of chickens totaling 27 birds which were fed one or more eggs mixed in their mash, all but 6 died of fowl typhoid in an average period of 9.4 days. Four survivors became reactors and the remaining 2 died of other causes. Incidentally, the survivors in group 5 were the progeny of typhoid reactors but were not exposed to an active outbreak of fowl typhoid.
CONTROL OF FOWL TYPHOID

Chart 1 shows graphically the total number of cases (eggs, infertile and dead embryos, and chicks) from which Sh. gallinarum was recovered in each hatch. This chart shows a rather distinct periodicity in chick outbreaks of fowl typhoid. Between the 18th and 36th hatches there were 4 peaks which were caused mainly by chick outbreaks which came about every 5th or 6th hatch.

PEN CONTACT TRANSMISSION

Twelve normal hens were put in a 12-compartment laying battery, in which 9 birds had just died of fowl typhoid. Three survivors were left in the battery until they died 4 to 8 days later. No cleaning of the battery was done before the susceptibles were put in. One susceptible bird was put in each compartment, including the 3 occupied compartments. Ten of these pen contact birds died of fowl typhoid in an average period of 10.8 days after pen contact exposure to Sh. gallinarum.

Table 4—Transmission of fowl typhoid by pen contact—Pen 19B

<table>
<thead>
<tr>
<th>NO. OF BIRDS</th>
<th>EXPOSURE</th>
<th>DEATHS</th>
<th>DAYS AFTER EXPOSURE</th>
<th>CAUSE OF DEATH</th>
<th>MORTALITY PERIOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Method</td>
<td>No.</td>
<td>Percent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>2-19</td>
<td>44</td>
<td>100</td>
<td>6.9</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>12</td>
<td>2-19</td>
<td>9</td>
<td>75</td>
<td>9.7</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>14</td>
<td>3-7</td>
<td>0</td>
<td></td>
<td>7.4</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>13</td>
<td>7-25</td>
<td>10</td>
<td>76.9</td>
<td>8.1</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>6</td>
<td>7-31</td>
<td>2</td>
<td>33.3</td>
<td>10.5</td>
<td>Fowl typhoid</td>
</tr>
<tr>
<td>6</td>
<td>8-6</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>9-4</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In another pen contact experiment, 57 normal birds were placed in a pen with 50 strong (3 or 4+) reactors and kept there for approximately 3 months. At the end of that time all were sacrificed, and from 10 percent of the normal exposed birds, all of which had remained healthy, Sh. gallinarum was isolated.

In a more recent pen contact experiment (Table 4) designed to test the transmissibility of an acute outbreak of fowl typhoid, 56 fowls were fed a virulent culture of Sh. gallinarum in their mash. In 10 days they were all dead of fowl typhoid but 3, which were removed on March 7, 1946. On the same day 14 fowls about 6 months old were placed in this pen, which was believed to be heavily contaminated with Sh. gallinarum. These birds remained in this pen approximately 4½ months, until July 25, 1946, up to which time no losses had occurred, and they remained negative to 5 rapid, whole-blood agglutination tests made at monthly intervals. On July 25, 1946, they were exposed to Sh. gallinarum by feeding the organism
in a wet mash and 8 of the 14 died in an average period of 7.4 days. Of 13 normal controls added on the same day and also exposed to the gallinarum contaminated feed 10 died of fowl typhoid in an average period of 8.1 days. Deaths from typhoid started in both groups on July 31 and continued until August 6. On July 31 a group of 6 susceptible males was added to this pen and of these 2 died of typhoid within 11 days. On August 6 six more normal males were added to this pen but no deaths occurred in this group up to October. On September 4 another group of 10 normal males was added to this pen but thus far no further deaths have occurred.

The results of this experiment indicate that at times some factors are lacking under experimental conditions which are necessary to bring about infection by contaminated pen contact or that unsanitary conditions are not as important in the spread of fowl typhoid as we have believed. These contaminated pen exposure trials are being continued.

SEROLOGICAL STUDIES WITH PULLORUM AND TYPHOID ANTIGENS

Gauger (8) conducted serological studies on 8 survivors of a fowl typhoid outbreak for a period of 34 to 40 weeks. All were positive in a dilution of 1:25 or greater. Both pullorum and gallinarum antigens were used, and a higher titer was obtained with Sh. gallinarum antigen. He states that a whole blood or tube agglutination test with S. pullorum or Sh. gallinarum antigen applied to survivors of a fowl typhoid outbreak within 2 or 3 months after the disease has subsided should probably remove a large percent, if not all birds, which are in the carrier stage.

As in pullorum disease reactors Moore (14) found intermittent reactors among a group of 35 typhoid reactors which were tested monthly for 13 times. Eleven, or 31.4 percent, of 35 artificially infected reactors were intermittent, but only 1 of 22 naturally infected reactors was intermittent.

In our artificially infected reactors, Pen 19A, 3 of 25, 12 percent, were intermittent, while in the naturally infected group, Pen 20A, of 38 birds, 7.9 percent were were intermittent as indicated by monthly whole-blood, rapid tests with both pullorum and typhoid antigens carried on for a year. As suggested by Moore intermittency is a good argument for repeated tests.

Wilson (21), using a rapid pullorum antigen in two field outbreaks of fowl typhoid as well as in experimentally infected fowls, obtained complete agreement with the tube test, and concluded that the rapid, whole-blood test was an accurate and efficient method of testing for fowl typhoid in the field.

Glover and Henderson (9) made comparative tube tests of a typhoid infected flock, using 2 pullorum antigens (standard and variant), and 2 gallinarum antigens (one isolated from the outbreak and one from Dr. Jungherr). The pullorum antigens in 1:25 dilution picked out 50 percent and 53 percent as reactors, respectively, while the gallinarum antigens picked out 86 percent and 88 percent, respectively. The rapid serum pullorum test picked out 38 percent as reactors.

Our 2 pens of typhoid reactors, Pen 20A, and Pen 19A, averaging about 60 birds have been tested monthly for the past year using both pullorum and gallinarum antigens. The whole-blood, rapid method has been used routinely, and occasionally a comparative tube test has been made. All of the rapid antigens made from
cultures sent in from Maryland, Delaware, and Virginia have also been tested comparatively with rapid K antigen, and in all of these tests the pullorum antigen gave an equal and in some cases a higher titer than the gallinarum antigens. In the beginning of our comparative plate tests, both in the field and in the laboratory, strain 18 gallinarum antigen gave a slightly higher titer than pullorum K antigen, but after a few months strain 18 gradually lost antigenicity, and was then combined with other strains into a polyvalent antigen. We are still trying to make a polyvalent typhoid antigen that is definitely superior to pullorum antigen for both tube and plate testing.

CONTROL OF FOWL TYPHOID

In November 1945 a meeting of poultry pathologists and disease control officials of Maryland, Delaware, and Virginia was called by the Bureau of Animal Industry in Washington to consider ways and means of controlling fowl typhoid on a regional basis. After considerable debate on the relative merits of typhoid and pullorum antigens for the detection of typhoid carriers, it was decided that the development of an accurate, reliable antigen by which typhoid carriers might be detected should be the first objective of the group. It was agreed that the poultry pathologists of the States represented would send cultures of Shigella gallinarum isolated by them to the U. S. Bureau of Animal Industry, where the cultures would be examined to determine which ones were most suitable for the making of polystrain typhoid antigens. Polyvalent antigens made from these selected cultures were then to be sent out to the States concerned, where sera obtained for the routine pullorum tests would also be run with the typhoid antigen to determine whether typhoid antigens are superior to the regular conference pullorum antigen* in detecting typhoid reactors by the tube test.

Moore (14) was the first to report on comparative tube tests of a typhoid infected flock of 106 birds using the standard pullorum antigen and a polyvalent typhoid antigen, M2, furnished by the U. S. Bureau of Animal Industry. The standard pullorum antigen picked 47 percent as typhoid reactors, the gallinarum antigen picked 60 percent, and a single strain typhoid antigen, $18$, picked 46 percent in the rapid serum test.

In a small number of comparative tube tests Moulthrop found 37.5 percent to react to the standard pullorum antigen and 87.5 percent to react to gallinarum antigen.

Cultures from the cooperating States have been slow in coming in but quite a large number have been processed during the fall, some of which are quite promising, and it is hoped that it will be possible to make antigens highly sensitive to the blood of typhoid infected birds for both the tube and plate tests.

Various methods have been suggested for the control of fowl typhoid such as 1) selling out and cleaning up, 2) culling and sanitation, 3) vaccination, 4) elimination of reactors by agglutination testing, and 5) sulfonamide therapy.

Many foreign investigators regard pullorum disease and fowl typhoid as closely related, or of common origin, if not identical, and many, including Panisset (17),

* The antigen made up from pullorum strains accepted by the Northeastern Conference of Laboratory Workers in Pullorum Disease Control.
Coles (5), Lesbouyries (12), Reis and Nobrega (18), and Talavera (19), advocate vaccination for the control of fowl typhoid. However, vaccination is advocated by few investigators in this country.

Kaupp and Dearstyne (10) recommend the following procedures for the control of fowl typhoid: Strict sanitation, destruction of sick birds, disinfection of drinking water, confinement of birds to new range, and vaccination of all healthy stock.

Although our main effort to control fowl typhoid is being directed toward the elimination of carriers by agglutination testing and the use of sanitary procedures, we have also tried other methods of control to a limited extent such as immunization by vaccination with killed cultures and bacteriophage, and also treatment with the sulfonamides.

Immunization and chemotherapy have been considered by us as more or less stopgap procedures but which might, however, be very useful in certain situations, particularly where the disease is enzootic and in broiler raising. In breeding establishments, however, a more far-reaching program looking toward eventual eradication seemed desirable. Our experimental work in egg transmission leads us to believe that the carrier is one of the most important means of transmission and perpetuation of the disease. It is for these reasons that control of the disease is being attempted by the elimination of carriers from breeding flocks by repeated agglutination testing.

Hammond (22) was successful in controlling fowl typhoid in a breeding flock by the use of repeated whole blood agglutination tests and the administration of sodium sulfathiazole in the drinking water.

An unusual opportunity to try measures for controlling fowl typhoid in a large breeding flock by the elimination of carriers presented itself in a large broiler raising area. Losses had been severe and almost continuous for the 2 preceding years. This flock was pullorum clean but the pullorum test usually made in the fall when the pullets are housed had no apparent effect on subsequent outbreaks of fowl typhoid. Preliminary, rapid, whole-blood agglutination tests of some breeding flocks in which there had been losses from typhoid showed 1 to 2 percent of reactors in houses of 5,000 capacity. In order to remove all reactors it was decided to carry on monthly tests until no more were found. When this program was completed on 60,000 layers no losses from typhoid were experienced for 8 months. In the latter part of the following summer, however, losses from typhoid were again experienced in some of the progeny on range when about 18 to 20 weeks old but not in chickens which were confined in broiler houses and sold when about 14 weeks of age. No cause has yet been found for this typhoid break. However, losses from fowl typhoid in these pullets after housing have been light this year.

SUMMARY AND CONCLUSIONS

A recent survey indicates an increase in fowl typhoid particularly along the eastern seaboard.

It is generally agreed by investigators that the egg is an important means of transmission of the disease.

In our work continuous culture of all eggs laid by a flock of trapnested fowl typhoid reactors over a period of 6 months has shown that:
1. Approximately 50 percent of the naturally infected reactors laid typhoid-infected eggs.
2. An average of 6 percent of all eggs laid by reactors are infected.
3. A few reactors lay infected eggs with every clutch while others lay such eggs intermittently.
4. Infected eggs are highly virulent and when eaten by susceptible birds cause a high mortality and may be the means of starting a new outbreak in a laying flock.
5. Outbreaks of typhoid in baby chicks which are the progeny of typhoid reactors tend to occur periodically.

Under the conditions of our experiments it was difficult to infect normal susceptible chickens by contact with typhoid-contaminated pens. That these same pen contact birds were susceptible was demonstrated by feeding them a virulent culture, which resulted in high mortality.

A small percentage of typhoid reactors show intermittency in reaction, thus indicating the necessity of repeated tests.

Although at least 3 investigators have reported gallinarum antigen to be superior to standard pullorum antigen in detecting typhoid reactors by the tube test, this has not been the case in our work either by the tube method or the rapid, whole-blood plate method.

The removal of reactors by repeated agglutination tests in conjunction with sanitary procedures is suggested as a method for the control of fowl typhoid.

ACKNOWLEDGMENT

The authors are indebted to H. W. Schoening and R. R. Henley for advice and encouragement in the pursuit of this work.

REFERENCES


NEWCASTLE DISEASE IN MINNESOTA

BY R. FENSTERMACHER, D.V.M., B. S. POMEROY, D.V.M., M.S., PH.D., AND
WINSTON A. MALQUIST, D.V.M.

University of Minnesota Agricultural Experiment Station, St. Paul, Minnesota

The literature relating to Newcastle disease will not be reviewed. This has been done most ably and comprehensively by Dr. F. R. Beaudette, whose paper was published in prior proceedings of this Association. Little did those of us who heard these reports or read the same realize that Newcastle disease was at that time present in the United States. There is little doubt that if the mortality of the disease had more nearly approached that which is reported to occur in outbreaks in Europe and other parts of the world, it would have been recognized at a much earlier date. If the infection had caused one hundred per cent losses among the birds of the infected flocks, the poultry industry would have become greatly alarmed and research workers would have had more reason to recognize the possible similarity of the disease as it appeared in other parts of the world in comparison with the disease as it has thus far occurred in the United States. Up to the present time, the mortality rate in the infected flocks in the United States has been much lower than in other parts of the world. It varies somewhat, but in most instances it is reported to be in the neighborhood of ten per cent. In certain flocks, the mortality approaches twenty per cent. We have had similar losses in Minnesota, but we have also had fifty per cent mortality, and in a few instances two-thirds of the birds in the flock died.

SYMPTOMS

The symptoms will not be described in detail. They are quite unlike in the pullet or hen in production in contrast to the baby chicks or young, growing chickens up to eight or ten weeks of age. There is no sex discrimination so far as susceptibility is concerned. The symptoms in the mature birds may include a slight coryza. A few of the birds may show nervous symptoms recognized by torsion of the neck; one or both wings may drop and be held in an irregular position. Birds may lose control of one or both limbs. A symptom that is forcibly impressed upon the owner is the very marked decrease in egg production. Not all of the flocks that have come under our observation have shown marked reduction in egg production; but, in most cases, egg production fell off suddenly. The reduction is rapid and dramatic to the owner. We have had cases where flocks were producing 200 or more eggs, and within five to six days production dropped to zero or very close to it. Resumption of egg production is gradual, and often takes a month or longer to return to the previous level. The mortality has been low in most instances, generally less than ten per cent.

The symptoms in young and growing chicks are more varied. The disease very commonly starts as a common cold. The birds may show symptoms of gasping,
sneezing, accompanied with a nasal discharge. Many of the birds emit a peculiar, rapid, low, cheeping sound. The respiratory symptoms may disappear within one week. Diarrhea may be an early symptom. The latter, however, is not a common observation. Within a few days, many of the affected chicks develop nervous symptoms. The latter consist of partial or complete paralysis of one or both legs, drooping or paralysis of one or both wings. The head and neck may be held down between the legs or be extended over the back, or it may present a half-twist appearance and be extended downward and forward. When the head is held in this position, the lower beak is uppermost. Another nervous symptom frequently observed is tremor of the head. The bird shakes the head rapidly from side to side or from anterior to posterior. Not too infrequently, it may hold the head and neck to either side so that one is reminded of an inverted question mark. Frequently, the birds walk or run backwards, at the same time presenting spiral-shaped positions of the neck as described above. Often, they may collapse and fall on one side or the other or upon their backs. These spasmodic symptoms are not continuous—they are intermittent. Between the nervous attacks, the birds may not, and they usually do not, appear to have anything seriously wrong with them. Often, in a battery housing affected birds, one may not see any birds showing nervous symptoms if there is freedom of noises. Any sudden noise, such as slamming a door or striking the wire on the side of the cage, will cause a sudden resumption of the nervous symptoms. The question is often asked whether the birds showing such extreme nervous symptoms are able to eat or drink. Most of them can do so and will feed during the intervals when the nervous symptoms are not apparent.

The symptoms of affected turkeys are not so pronounced. The nearly mature turkeys seldom show nervous symptoms. As a rule, the owner is not aware that there is anything wrong. The most common symptom observed is a snuffing or sneezing sound. The way they do it suggests the presence of respiratory infection, not so much an involvement of the upper portion of the tract, but rather the lower portion—the air sacs. Sinusitis is not believed to be involved in this disease. Losses do occur among the mature birds.

Since turkeys are not in egg production in the late autumn, nothing is known in regard to egg production. The young poults, like the young chicks, show evidence of respiratory trouble very early in life, a matter of two or three days of age. We have had the opportunity of observing only one outbreak of a field case among young poults. At no time did they show any nervous symptoms. They did a lot of snuffing or sneezing. In this instance, a sixty per cent mortality occurred during the first three weeks of their life.

**DIAGNOSIS**

Diagnosis is exceedingly difficult. It may be confused with some of the more commonly occurring respiratory ailments such as infectious bronchitis, coryza, and laryngotracheitis. The nervous form of the disease may, in very young chicks, be easily confused with nutritional disorders; and, as they get older, it may be confused with the fowl paralysis complex, botulism, vitamin E deficiency, and avian encephalomyelitis. For some unknown reason, we frequently encounter turkeys and
chickens, which demonstrate dysfunction of the central nervous system, that manifest symptoms not unlike those observed in Newcastle disease in young birds, that are due to a Pasteurella infection localized in the brain.

Without any reflection upon the practicing veterinarian's diagnostic ability, it is believed that the diagnosis of Newcastle disease is the job of a properly equipped laboratory. There are several recognized methods of diagnosis: (1) the hemagglutination and hemagglutination-inhibition test, (2) serum-virus neutralization test, and (3) the isolation of the virus from the tissues of the bird. The first two methods have their limitations, and it must be recognized that some failures may be due to obtaining blood serum before sufficient time has elapsed to permit the development of the inhibiting substances. Failure to recover the virus from affected birds may be due to the disappearance of the virus.

**AUTOPSY FINDINGS**

Post-mortem examinations in the field are not too helpful and may, on the other hand, be dangerous, as such examinations might prove to be an excellent way of spreading the disease. Contaminated hands and clothes might be a means of carrying the disease to neighboring farms.

In other parts of the world, the lesions found at autopsy are much more pronounced than they occur with the disease as it exists in the United States. Many autopsies are completely negative. The characteristic lesions thus far observed consist of a thickening and cloudy appearance of the lower air sac walls. The spleen, if pathologic in appearance, is somewhat enlarged and has a blue-purple color.

We are not certain that the air sac changes as found in the mature or nearly mature turkey are the sole result of the virus of Newcastle disease. We recognize the possibility of a complication with some other unknown factor. At least the air sacs, both lower and upper, but more frequently the former, are seriously involved in the majority of instances. The walls are thickened, and the space within is filled with a caseous-like material that is white, to gray, to yellowish in color. Sometimes the content is fluid and has the same color as the caseous material. The amount of material that is frequently found in the lower air sacs is surprising. In young poult, the changes of the air sac walls consist of a thickening and cloudy appearance. Rarely does one find an accumulation within the air sacs.

**INCIDENCE OF DISEASE**

Pneumo-encephalitis, indistinguishable serologically from Newcastle disease has existed in California for approximately ten years. Newcastle disease appeared in New Jersey during February of 1945. It was first recognized to be present in Minnesota in May of 1946. No attempt will be made to explain the method of transmission from the west to the east coast of the United States. Neither do we definitely know when it was first introduced in Minnesota. Certainly, we were on the lookout for the disease even before its presence was reported in New Jersey. The first case involved a shipment of day-old poult originating from Michigan. The consignment contained 150 poult of which 40 died during the first ten days. Four dead and two live, ten-day-old poult were examined. Paratyphoid organ-
isms were recovered from the intestinal tract of two poults. By the time the turkeys were four months old, ninety birds had died. A virus, recovered from the spleen and air sac walls, was sent to the Pathological Division of the Bureau of Animal Industry at Washington, D.C., for identification purposes. It was identified as the virus of Newcastle disease. The next two positive cases involved chickens and were diagnosed during the early part of June. In one instance, the birds were located in Wisconsin and in the other in North Dakota. It was during the middle of June that the first flock of affected chickens was found in Minnesota. They were battery-raised chicks and consisted of 10,000 birds. The ages varied from three to eight weeks. The mortality was 5,000 birds. The remainder were destroyed, and the premises were cleaned and disinfected. An official quarantine was established on the birds and premises as soon as it was suspected that Newcastle disease existed. The U.S. Bureau of Animal Industry at Washington, D.C., confirmed the diagnosis of Newcastle disease. We are, indeed, greatly appreciative of the assistance rendered to us during the first few months of the outbreak. Without such assistance, we would have been seriously handicapped. The presence of the disease became more apparent during the first part of July within the State when several shipments of started pullets from Missouri were found affected upon their arrival. More and more cases began to appear so that at the present time, thirty-six different flocks of chickens are known to have the disease. These are located in twenty counties of the eighty-seven counties within the State. The infection is quite widely disseminated throughout the State with the exception of the northeastern portion. This is the part of the State that is least populated and there is very little poultry in the area. Of late, letters are being received more frequently stating that pullets and hens are going off production, and in most instances the rate of reduction is quite rapid.

The disease among turkeys is giving us great concern. It appears as though the disease has some variations in contrast to chickens. For example, the virus was recovered from ten-day-old poults. This was done during the latter part of May. Serums were collected four months later from a number of the survivors and were tested for inhibiting substances against Newcastle virus, and the results were negative.

An experimental flock of turkeys consisting of about 800 birds has been maintained during the past four or five years by the Division of Veterinary Medicine. This flock has been used for research purposes in connection with pullorum disease and paratyphoid infections. During the past three years, there has been a great deal of air sac infection present which began generally when the birds were five to six weeks of age. The infection always became more serious as they became older so that by the time they were fourteen to twenty weeks of age, practically all were showing evidence of air sac infection. Even though care was taken, three or four birds usually died suddenly when the birds were being bled. Breeders were selected during December, and losses continued in this group during hatching season. This condition was investigated rather intensively when the birds were approaching market age. We were able to transmit the condition to other turkeys only in a very few instances. On a few occasions, an atypical Pasteurella organism was isolated. Mention should be made that we are studying Salmonella infections of turkeys and that the breeders were reactors to several Salmonella types of infec.
NEWCASTLE DISEASE IN MINNESOTA

During December of 1945, all of the turkeys were destroyed. The premises were cleaned and disinfected thoroughly in an effort to eliminate, if at all possible, all infection. Poults were purchased during April of 1946, from a flock of turkeys considered to be free of Salmonella and air sac infection. In spite of these precautions, air sac infection reappeared during September. On account of the presence of Newcastle disease, a fair sample of blood serums was collected from these turkeys and was tested early in September to ascertain whether or not the serums contained any inhibiting substances against Newcastle virus. The results were negative. The flock was again sampled six weeks later and the inhibiting powers of 320 were common. We strongly suspect that the air sac infection, as it has occurred in this flock, is the result of the virus of Newcastle disease. At this time, we are in the process of making that determination. The State employs two mobile laboratories that are engaged in the testing of turkeys for pullorum disease. Serum samples from the majority of the flocks are being tested to determine the presence or absence of inhibiting substances against Newcastle virus. Of the first thirty flocks tested, five have been found to contain a high inhibition power. As the work continues, interesting data should be obtained.

It is impossible to know what can be expected to occur in the future. One thing certain, the outlook is anything but pleasant. We have a large turkey industry in the State, and many large and small operators have begun to maintain their own breeding stock. If they should have just some of the difficulty we have had, it is reasonable to suppose that their chance to prosper is not encouraging. No one can give us any assurance that the virus will not become more virulent. Should this occur, then the outlook for the poultry industry is not pleasant to think about. It is regrettable that the poultry industry of the United States is so apathetic in regard to the significance and presence of this disease. Their attitude relative to accepting it as just another disease with which to live makes it most difficult for livestock sanitary officials to control the disease. Without the whole-hearted support of the poultry industry, successful control seems impossible.

**SUSCEPTIBILITY OF TURKEY POULTS TO NEWCASTLE DISEASE**

Twelve turkey poults ranging in age from two to four weeks were separated into two groups of six birds each. Each bird was bled prior to inoculation, and the serum-inhibiting power was tested by the serum-inhibition method, using turkey red cells instead of avian red cells. The average inhibiting power was 5. One lot was inoculated intramuscularly with 0.25 cc. of infectious chorio-allantoic fluid. The other group was inoculated by dropping 0.10 cc. of the fluid into the trachea via the larynx. One poult which was inoculated by the intra-tracheal route showed severe gasping five days later. On the sixth day, all poults were sneezing and gasping. One poult died on the twelfth day. Autopsy revealed severely-infected lower air sacs. The remaining turkeys were bled two weeks after inoculation, and the serums were tested for inhibiting power. All of the serums showed an inhibiting power of 1280 without reaching the end point of titration.

**SUSCEPTIBILITY OF UPLAND BIRDS TO NEWCASTLE DISEASE**

Several reports have indicated that wild birds are susceptible to Newcastle disease and may become an important factor in the spread of the disease. In case
of susceptibility and subsequent recovery, the possibility of serving as a reservoir of infection is another phase that should be investigated. The majority of the reports, however, arise from circumstantial evidence based upon observations made during outbreaks in poultry. Several species of upland game birds are found in Minnesota, some of which more or less come in contact with poultry. An experiment was conducted to test the susceptibility of four species of upland game birds by artificial inoculation with Newcastle virus. The game birds were furnished by the Minnesota Department of Conservation through the excellent cooperation of the director of Game and Fish Division, Mr. Frank Blair. The following species were used: Chinese ring-neck pheasants (Phasianus colchicus torquatus), Chukar partridges (Alectoris graeca chukar), Hungarian partridge (Perdix perdix perdix) and quail (Colinus virginianus virginianus).

Each lot of the above species contained six birds. Each species lot was divided into two groups of three birds each and were kept in separate cages. Before inoculation, each bird was bled, and the inhibiting power of the serum was determined by the serum inhibition method using avian red cells. Infectious chorio-allantoic fluid, which had at least a titre of $10^6$ chick embryo M.L.D.'s of virus per 0.10 cc., was used as the inoculum. One lot of three birds of each species was inoculated intramuscularly, and the remainder, consisting of three birds of each species, was inoculated intratracheally. Several observations were made daily, and the time when the first symptoms were apparent was noted.

One Hungarian partridge, inoculated intramuscularly, showed symptoms of Newcastle disease as early as 72 hours after inoculation, and the remaining birds became ill within 96 hours. The first symptoms noted were depression and a marked lack of movement about the cage when disturbed. Twenty-four hours later, wing and leg weakness appeared. This was manifested by an inability to flutter their wings and by walking about on their hocks. Shortly thereafter, they lost their ability to move about, rested on their sternum with head extended so that the beak was on the floor of the cage. While in this position, the head was more or less constantly raised and lowered. The three birds inoculated intramuscularly died within forty-eight hours after the initial symptoms were observed. Autopsy revealed no gross pathology, but the virus was recovered from each bird. A longer period of incubation was observed following the intratracheal route of inoculation, and the symptoms were less uniform. One bird became ill at the end of 120 hours and the symptoms were similar to those above. One other bird showed leg weakness and nervous symptoms ten days after inoculation. This bird made a gradual recovery during the following nine days. The remaining bird never showed evidence of infection. Respiratory symptoms were not observed in any of the Hungarian partridge.

The Chinese pheasants, the quail, and the Chukar partridges failed to show any symptoms of disease. All birds of these three groups included in the experiment showed a high inhibiting power when their serums were tested two weeks after they were inoculated.

Table 1 shows the inhibiting power of the blood serum, the route of inoculation, the average pre-inoculation inhibiting power of the serums and other observations and results.
NEWCASTLE DISEASE IN MINNESOTA

The birds used in the experiment originated from the game farms of the Minnesota Department of Conservation. Since no illness was present among the game birds on the farms, the birds on the farms served as the controls for the preliminary experiment herein reported.

Table 1.—Summary of experimental results obtained by inoculating artificially 24 game birds and 2 racing pigeons with Newcastle disease virus. Each lot of the upland species contained three birds.

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>ROUTE OF INOCULATION</th>
<th>AMOUNT OF INOCULUM</th>
<th>AVERAGE PREINOCULATION INHIBITING POWER</th>
<th>POST INOCULATION INHIBITING POWER</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinese pheasants</td>
<td>I.M.</td>
<td>.25 cc.</td>
<td>serum</td>
<td>1280</td>
<td>Not sick</td>
</tr>
<tr>
<td></td>
<td>I.T.</td>
<td>.10</td>
<td>jelled</td>
<td>1280</td>
<td>Not sick</td>
</tr>
<tr>
<td>Chukar partridge</td>
<td>I.M.</td>
<td>.25</td>
<td>5</td>
<td>1280</td>
<td>Not sick</td>
</tr>
<tr>
<td></td>
<td>I.T.</td>
<td>.10</td>
<td>5</td>
<td>1280</td>
<td>Not sick</td>
</tr>
<tr>
<td>Quail</td>
<td>I.M.</td>
<td>.25</td>
<td>5</td>
<td>1280</td>
<td>Not sick</td>
</tr>
<tr>
<td></td>
<td>I.T.</td>
<td>.10</td>
<td>5</td>
<td>1280</td>
<td>Not sick</td>
</tr>
<tr>
<td>Hungarian partridge</td>
<td>I.M.</td>
<td>.25</td>
<td></td>
<td>1280</td>
<td>100% mortality</td>
</tr>
<tr>
<td></td>
<td>I.T.</td>
<td>.10</td>
<td></td>
<td>1280</td>
<td>33% mortality</td>
</tr>
<tr>
<td>Racing pigeons</td>
<td>I.M.</td>
<td>.25</td>
<td></td>
<td>1280</td>
<td>66% susceptibility</td>
</tr>
</tbody>
</table>

* End point of serum inhibition not reached.

SUSCEPTIBILITY OF PIGEONS TO NEWCASTLE DISEASE

Two racing pigeons (*Columba livia*) were inoculated intramuscularly with the same inoculum and the same dosage as the upland birds. They showed no evidence of illness. Their blood serums did, however, develop high inhibiting power as shown in Table 1.

One Ring dove (*Streptopelia risoria*) was injected in the same manner as the above. The bird became ill; showed the same symptoms as the Hungarian partridges that were injected intramuscularly and died within 96 hours.
OBSERVATIONS ON THE SPREAD OF NEWCASTLE DISEASE

BY ERWIN JUNGHERR, VET. DIPL., D.M.V., AND NAOMI TERRELL, B.A.

Department of Animal Diseases, Storrs Agricultural Experiment Station, University of Connecticut, Storrs, Conn.

The epizootiology of Newcastle disease on a world-wide basis, particularly with respect to geographic distribution and zoologic spectrum of susceptibility, has been given detailed consideration in a recent paper by Brandly, et al (3). These authors discussed the various modes of dissemination of the disease, according to opinions, expressed in the literature. Beach (1) after long experience with the disease, stated flatly that the mode of spread from farm to farm and to new districts was not determined. In particular he did not believe carriers to be an important factor in view of the restricted movement of adult stock from one farm to another. Baby chicks and hatching eggs even from endemic areas, have not been incriminated in California in the transmission of the disease, neither in intra nor interstate traffic.

The lack of adequate information on the natural modes of transmission, which question is of equal importance to both poultrymen and livestock sanitarians, has been felt keenly by the National Newcastle Committee. In response to suggested control measures for various segments of the Poultry Industry, such as breeders, hatcheries, shows, contests and auctions, representatives of these segments produced testimonial evidence that their particular branch could not be implicated in major dissemination. Nevertheless, incontrovertible evidence has come forth as to the renewed spread of the disease, particularly in the Midwest. The gap between opinions and observed facts reiterates the need for further investigations along these lines. In such studies a reasonably well supported positive observation may often be more illuminating than a number of negative observations even if made over a period of time.

In the present communication an attempt has been made to analyze the available data on the occurrence of the disease in Connecticut from the standpoint of the probable modes of spread. Since the recognition of Newcastle disease on the eastern seaboard is of relatively recent origin, these observations should be considered only as a beginning in developing a broad concept on this fundamental feature of the disease.

OCCURRENCE OF NEWCASTLE DISEASE IN CONNECTICUT

The first evidence based on neutralization tests that a Connecticut flock has had experience with Newcastle disease prior to the winter of 1942/43, was presented by Minard and Jungherr (5). The affected population was later shown (2) to have retained significant levels of antibodies for an additional three years while subsequent populations on the same premises have remained free from significant neutralizing antibodies to this date. At no time was there any clinical evidence of Newcastle disease during the period of observation. The California virus which had been used in these neutralization tests, was destroyed at the request of the
SPREAD OF NEWCASTLE DISEASE

Bureau of Animal Industry, in December 1943, so that no further tests could be carried out until the virus was recovered from Connecticut flocks.

In August of 1945, a flock of four-month-old pullets became affected with a respiratory disease, which on subsequent neutralization tests with stored serum samples proved to be Newcastle disease.

During October 1945 a Massachusetts hatchery shipped lots of 5000 to 8000 day-old chicks to five different Connecticut broiler plants. According to the owners, respiratory symptoms and mortality were noted either on arrival or within the first 96 hours. Newcastle disease virus was isolated from chicks originating on three different premises and significant neutralizing antibodies were demonstrated in numerous serum samples obtained from recovered chicks 5 to 7 weeks later. While four of these five premises were located in adjoining townships of eastcentral Connecticut, they were quarantined immediately by the Commissioner on Domestic Animals; thus, it would appear unlikely that these foci were the source of subsequent outbreaks in the state.

The above cases were followed by two communal outbreaks in December 1945 and January 1946. The first one occurred in the northcentral section of the state east of the Connecticut river. A large poultry plant and at least two adjacent farms were shown to be affected on the basis of virus isolation or neutralization tests, while additional premises in this region reported similar trouble at the same time. The condition on the large plant was followed by repeated specimen examination till October 1946 and will be discussed below. The second communal outbreak occurred geographically near the October focus, but two to three months later.

During the five-week period following Christmas, six different cases of Newcastle disease were diagnosed either in adult birds or chicks, and an additional four cases were reported verbally. Two hatcheries who also maintained breeding flocks seemed to be involved since in one case both the adult stock and chicks sold were found affected, and in the other instance chicks sold came down with the disease. As soon as the diagnosis became known, a large number of adult birds in this region was marketed voluntarily which action brought the outbreak under control.

In January 1946 sporadic outbreaks began to occur west of the Connecticut river and continued primarily through March, while during the same period the number of cases decreased in the eastern section of the state. However, the disease was still demonstrated by virus isolation in western Connecticut as late as August 1946. Two cases were recognized in turkeys on the basis of serum neutralization tests.

The overall epizootiologic situation from the standpoint of geography and chronology has been depicted in the accompanying charts.

STATISTICAL INCIDENCE

In establishing the diagnosis of Newcastle disease, the methods used included clinical examination, gross and histologic observations, serum neutralization tests, hemagglutination and hemagglutination-inhibition tests, and isolation of the virus. The virologic methods were similar to those described in the recent literature and tallied in general with the ones suggested by the Bureau of Animal Industry under dates of August 15, and October 21, 1946.
SPREAD OF NEWCASTLE DISEASE

Chart 2. Chronological distribution of Newcastle disease
In the evaluation of the diagnostic results three methods were considered, namely virus isolation, neutralization tests, and clinico-pathologic examination, in the preferential order named. The diagnosis in each case was recorded according to the highest ranking positive diagnostic test obtained.

The statistical incidence of Newcastle disease in Connecticut during the period of from August 1945 to October 1946 has been summarized in table 1. The data have been grouped according to cases in birds up to 30, 120, and 360 days, of age. There was a total of 56 cases in chickens and 2 in turkeys, of which 29 occurred in chicks, 8 in growing birds (plus 1 turkey case), and 26 in adults (plus 1 turkey case). In 3 cases the disease was observed in brooder chicks (on one farm in both battery and floor chicks) and adult birds on the same premises, and in one instance in brooder chicks and growing stock, and in two instances in growing birds and adults.

### Table 1.—Statistical incidence of Newcastle disease in Connecticut from August 1945 to October 1946

<table>
<thead>
<tr>
<th>NUMBER OF CASES</th>
<th>AGE IN DAYS AT FIRST SYMPTOMS</th>
<th>TOTAL NUMBER IN AFFECTED AGE GROUP</th>
<th>PERCENT MORBIDTY</th>
<th>PERCENT MORTALITY</th>
<th>PERCENT DROP IN EGG PRODUCTION</th>
<th>DIAGNOSIS BY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Average</td>
<td>Range</td>
<td>Average</td>
<td>Range</td>
<td>Average</td>
</tr>
<tr>
<td>29</td>
<td>11</td>
<td>113,940</td>
<td>80</td>
<td>6-100</td>
<td>23</td>
<td>1-56</td>
</tr>
<tr>
<td>8</td>
<td>81</td>
<td>81-90</td>
<td>22,500</td>
<td>125</td>
<td>16-100</td>
<td>4.0</td>
</tr>
<tr>
<td>26</td>
<td>270</td>
<td>270-330</td>
<td>104,450</td>
<td>163</td>
<td>8-100</td>
<td>1.8</td>
</tr>
<tr>
<td>63*</td>
<td>240</td>
<td>240-288</td>
<td>64,890</td>
<td>100</td>
<td>6-100</td>
<td>1.8</td>
</tr>
</tbody>
</table>

* 7 cases in different age groups on same farm counted more than once. Actual total of cases in chickens 56, in turkeys (T) 2.

Cl.P., clinical and pathologic examination; N.A., neutralizing antibodies $10^9$ or over, V.I., virus isolation.

The diagnosis was based on clinical and pathologic examinations in 8 cases in which there was significant pathologic and epizootiologic evidence that the disease was Newcastle disease; in 31 cases of chickens and 2 of turkeys on demonstration of 1000 or over serum neutralizing doses; and in 24 cases on virus isolation. While the distribution of positive diagnoses in the age groups may be seen from table 1 attention should be called to the fact that in an approximately equal number of cases in brooder chicks and adult birds, the virus was isolated from chicks 21 times in comparison with 2 times in adults. Neutralization tests, on the other hand, were positive in chicks 3 times as against 23 times in adults. These observations illustrated the difficulty of virus isolation from adult birds. The general import of the above tests was signified by negative serum neutralization and negative virus isolation tests on another 100 different flocks in the state.
The findings in chicks were of particular interest since they were distinctly at variance with the experience in California (1). Even in New York state up until February 1946, as revealed at a regional meeting, Newcastle disease had been seen primarily in growing and adult stock while a few months later at the Washington meeting in May 1946, Dr. P. P. Levine reported the condition also in chicks. Thus, it appeared that the observations on the disease in Connecticut chicks in October 1945 constituted the first recorded outbreaks in this particular age group.

Newcastle disease in chicks made its clinical appearance sometimes within 24 hours after arrival from the hatchery and on an average after 11 days. If six cases in chicks in which the disease appeared after the age of 20 days, were discounted, the average age would be 8 days. In similar cases of infectious bronchitis in chicks one could not help but to consider the possibility of hatchery transmission. That Newcastle disease in susceptible chicks had a severe and rapid course, was indicated by a mortality range of from 1 to 56 percent with an average of 23 percent. Since the mortality data in some cases were obtained at the inception of the outbreak, the actual mortality both as to maximum and average may have been considerably higher. The course of the disease in growing birds and adult stock with respect to morbidity, mortality and drop in egg production in laying birds conformed in a measure to the usual reports. The 2 cases in turkeys were more or less accidental findings since the one in poults also showed blackhead, and the other case in adults, aspergillosis. However, both flock owners reported widespread unthriftness and mild respiratory symptoms, which could not be satisfactorily explained on the basis of the obvious pathology. Serum neutralization tests furnished the clue to the underlying respiratory condition.

The relationship of the incidence of the disease to season was illustrated by the frequent occurrence of active outbreaks during the winter months. As positive neutralization tests without an associated clinical syndrome must be considered as indicative of past experience with Newcastle disease without fixing the time elapsed since infection, virus isolation alone can be regarded as establishing an active outbreak. The available data on cases confirmed by virus isolation showed a seasonal distribution as follows:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases</td>
<td>3</td>
<td>4</td>
<td>8</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Thus, it would appear that inclement weather may act as a modifying and predisposing, but not as a determining, factor in the clinical course of Newcastle disease.

** Probable Modes of Spread **

Studies on the natural history of any virus-induced disease are handicapped by the invisibility of the causative agent, whose mode of travel can not be followed. Therefore, the science of epidemiology always must make certain assumptions. In this study, a special attempt was made to determine as far as possible, the spread of Newcastle disease in the cases observed. The laboratory work was supplemented by detailed case histories and follow-up surveys in cooperation with the Commissioner on Domestic Animals.

*Interage-group transmission on same farm.* A flock of 500 adult birds was affected
with an undetermined respiratory disease in November 1945. Three hundred day-old chicks obtained from a commercial hatchery in the last week of December were brooded in the same house. The attendant had to pass through the laying pens to reach the chicks. After 7 days of normal development the chicks showed respiratory-nervous symptoms and a mortality of 8 percent; Newcastle virus was isolated. A thorough check-up on other shipments from the same hatchery failed to reveal similar cases so that transmission on the same farm appeared most likely.

Of a flock of 20,000 chickens, 8000 layers suffered an acute attack of Newcastle disease in January 1946 which was diagnosed by neutralization tests. The remaining 12,000 two-week-old chicks were purchased from two different breeder hatcheries one of which was known to have had experience with Newcastle disease in the preceding month, while the other one was free from demonstrable antibodies. The chicks from the Newcastle disease affected hatchery showed only sporadic cases of mild respiratory disease and no mortality, the second lot had a severe outbreak and high mortality. This field experience confirmed the experimental work of Brandly et al (4) and illustrated the influence of congenital passive immunity conferred to chicks by immune hens and the consequent modification of the clinical course of the disease.

Another farm with a population of 18,000 growing and adult birds experienced a widespread outbreak of Newcastle disease in January 1946 and was completely depopulated and sanitized. Three weeks thereafter, the premises were restocked with 9000 day-old chicks. At the age of 14 weeks these birds showed an undetermined respiratory disease. However, 1500 day-old chicks obtained 6 weeks after the outbreak, came down, at the age of 4 weeks, with a similar disease which was diagnosed as Newcastle disease by neutralization tests.

On a poultry farm with a population of over 2000, 300 four-month-old birds showed in July, 1946, respiratory symptoms accompanied by a mortality of 2 percent and by positive neutralization tests. Nine days later 300 twelve-month-old birds also showed respiratory symptoms and a 36 percent decrease in egg production. Although serum neutralization tests at the inception of the secondary outbreak were negative, eggs from the adult stock collected 2 weeks later exhibited as high as one million doses of neutralizing antibodies.

On a poultry farm of 3000 birds, 2000 nine-month-old chickens showed, in January 1946, a respiratory-nervous syndrome which was diagnosed as Newcastle disease by serum neutralization tests. Three weeks later 1000 two-week-old birds, purchased as day-old from a hatchery, exhibited clinical and pathologic respiratory tract involvement and a mortality of 9 percent. Virus could not be recovered from the limited specimens submitted.

In a flock of 5000, 1600 eleven-month-old birds showed mild respiratory symptoms accompanied by a 35 percent drop in egg production, in April 1946. Serum neutralization tests were positive. All pens, with the exception of one, became affected over a period of two weeks. One week after the beginning of the outbreak, 3600 seven-day-old chicks came down with the disease as diagnosed by virus isolation.

In March 1946, a premise housing 14,000 chickens suffered a respiratory disease in 4000 two-month-old birds which proved to be positive on neutralization tests.
SPREAD OF NEWCASTLE DISEASE

Four weeks later, similar respiratory and also nervous symptoms appeared in 5000 four-week-old birds and the virus was isolated.

From the above examples the spread of Newcastle disease by direct or indirect contact on the same farm appeared probable, either from adult birds to chicks or from growing stock to chicks or adults.

Spread from farm to farm. In one of the above cases the occurrence of Newcastle disease was particularly surprising in view of the extremely careful management known to the authors. Furthermore, the flock had been free from respiratory troubles for several years. However, another poultry farm located within one half mile experienced a severe respiratory disease one week prior to the outbreak in question. The neighbouring owner decided to depopulate on account of the acute drop in egg production, but refused permission for specimen examination. The topography of the premises and the known disease history of the flock pointed toward interfarm transmission as the most likely possibility.

Inapparent outbreaks and inapparent spread. The following cases were illustrative of the insidious nature of the disease. A large experimental flock had been maintained as a closed unit for commercial nutritional tests for several years, without experiencing an overt respiratory disease. Most of the birds were housed in sanitary batteries located in air conditioned rooms. In view of the history of the flock 26 ten-week-old birds were brought to the laboratory for respiratory disease experiments in July 1946. Preinoculation neutralization tests for Newcastle disease were positive. Inquiry revealed that a group of laying birds had experienced an unexplained drop in egg production of one month's duration in the preceding January and had been disposed of. Subsequent neutralization tests on other birds ranging from 5 to 13 months in age, were positive, also neutralization tests on hatching eggs and on three-week-old chicks derived therefrom. However, when these chicks were retested at the age of 5 and 8 weeks, they were found to be negative.

A double entry in the Storrs Egg Laying Contest from an out-of-state poultry establishment had made an outstanding record by the close of the contest year and was sold tentatively to a foreign country pending demonstration of freedom from Newcastle disease. Of the 26 birds tested, 7 proved positive and 8 doubtful on serum neutralization tests, although the owner disclaimed any knowledge as to having had Newcastle disease on the home plant. Spleen, lung, trachea, liver, gall bladder, bone marrow and brain from four of these positive birds failed to yield Newcastle virus. At the same time, 30 birds from three other pens of the same contest did not show significant neutralizing antibodies.

On a large poultry plant which comprised about 30,000 birds, and which apparently constituted the center of the first communal outbreak in December 1945, an unusual opportunity offered itself for follow-up studies. At first the disease was diagnosed by virus isolation in eleven and seven-month-old stock and within a short time, in one and three-week-old brooder chicks. The outbreak spread throughout the entire plant by January when the clinical symptoms subsided. Birds which were just hatched at that time, proved likewise positive in July and August. However, birds hatched in March and April, 1946, i.e. two to three months following the cessation of the active outbreak, also proved positive to neutralization tests in September and October, which would indicate an inapparent
spread by carriers. The details of these studies have been summarized in table 2.

*Spread from breeder hatchery to chick customer.* To a flock of 1000 twelve-month-old birds which had no history of respiratory disease, an addition was made of 2000 day-old chicks from a breeder hatchery in January 1946. Within one day after arrival mortality commenced and rose to 17 percent during the following three weeks at which time some of the survivors showed typical nervous symptoms. Newcastle virus was isolated. On inquiry it developed that 5000 breeding birds of the hatchery likewise had experienced a severe respiratory outbreak in early January and were disposed of summarily which circumstance prevented examination of specimens. That the owner of the hatchery himself had become suspicious of Newcastle disease was apparent from the unusual disposal of the breeding flock at the virtual start of the hatching season.

**Table 2.—Inapparent spread of Newcastle disease in a self-contained flock of about 30,000 birds**

Reactions of age groups tested in month

<table>
<thead>
<tr>
<th>APPROX. AGE GROUP</th>
<th>DEC. 1945</th>
<th>JAN. 1946</th>
<th>MAY</th>
<th>JUNE</th>
<th>AUGUST</th>
<th>SEPT.</th>
<th>OCT. 1946</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td></td>
<td></td>
<td>+ + +</td>
<td></td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td>+ + +</td>
<td></td>
<td></td>
<td></td>
<td>+ + +</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>+ + +</td>
<td></td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>+ + +</td>
<td></td>
<td></td>
<td></td>
<td>+ + +</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>+ + +</td>
<td></td>
<td></td>
<td></td>
<td>+ + +</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>+ + +</td>
<td></td>
<td></td>
<td></td>
<td>+ + +</td>
</tr>
</tbody>
</table>

Cl. P., clinical and pathological evidence of Newcastle disease; N.A., Newcastle disease neutralizing antibodies 10^6 or over; V.I., isolation of Newcastle disease virus. +, test positive; −, test negative; blank space, not done.

End of clinical outbreak in winter 1945/46.

*Spread from commercial hatchery.* The possible rôle of the hatchery in the dissemination of Newcastle disease was demonstrated in the first outbreak in Connecticut established by virus isolations and neutralization tests. The diagnosis was confirmed on two virus strains submitted to the Bureau of Animal Industry.

The establishment was located in Massachusetts and conducted a commercial hatchery and a dressing plant in separate although adjacent, buildings. Both branches had individual staffs but workers occasionally went from one branch to the other and were permitted to drive home in the trucks used to deliver chicks. No out-of-state chickens had been dressed since July but empty egg cases had been received from New Jersey early in October.

On October 2, 1945, the above hatchery shipped 8800 day-old chicks of which 2800 were sent to a Massachusetts farm without subsequent trouble. The remaining 6000 went to a Connecticut consignee whose plant at that time contained a small
lot of one-week-old chicks from another hatchery. Within 24 hours the middle pen of chicks on the first floor began to sniffle and within 3 days the pens adjoining at either side were affected. A few days later the pens on the second floor became affected, occasionally with a pen mortality of 75 percent, in comparison with an overall mortality of 13 percent. Upon advice of the hatchery 200 unaffected chicks from a different hatchery were put into an affected pen and promptly contracted the disease. The older chicks on the farm came down with symptoms at the age of 5 weeks and suffered a set-back in growth but only minor mortality.

A hatch of 5200 chicks came off October 5th and went in lots of 2600 and 1600 to Massachusetts and Maryland, respectively. No trouble was reported to the hatchery.

On October 9, a hatch of 9000 chicks went to a Connecticut farm which had been cleaned and depopulated at time of receipt. Symptoms of gaping and coughing appeared within 24 hours and reached a peak on the 13th day of brooding, with development of what was described as typical ‘crazy’ chick symptoms. By the last of the month mortality began to decrease and subsided by the middle of November; it amounted to a total of 47.5 percent. Other chicks hatched at the same time and sold to a Massachusetts farm, were reported affected. On October 30, a repeat shipment of 7800 chicks was placed into new houses and the disease appeared within 12 days.

On October 12, the hatchery shipped 2200 chicks to Maryland and Connecticut without known subsequent trouble. The rest of the hatch, namely 5843 chicks, was trucked to a Connecticut farm, already stocked with 5800 two to three-week-old birds from another source. On arrival some of the above chicks exhibited symptoms of chilling, sneezing and photophobia, which condition spread throughout the shipment and caused a mortality of approximately 45 percent within 5 weeks. The older lot of birds also came down with the disease when 6 to 7 weeks of age and suffered a total mortality of 17 percent.

On October 19, 5000 baby chicks were delivered by the hatchery to another Connecticut farm that already had 4200 chicks on the premises. Within 4 days the newly arrived chicks exhibited symptoms; the ensuing mortality was stated to have been 32 percent. Ten days after the clinical onset of the disease, the 4200 became affected with a resulting mortality of 40 percent. Late affected chicks displayed nervous symptoms in both lots.

Between November 16 and 20, 1945, the above hatchery carried out a thorough program of formalin-fumigation of the incubators and corresponding rooms. That the concentration of the fumigant was of unusual strength was indicated by the fact that all eggs incubating at that time were thereby accidentally destroyed. The battery brooder room was not included because it had been vacant for two weeks and was thus believed to be safe. The room was then stocked with 2500 chicks which contracted the disease and suffered a mortality of 10 percent within 13 days.
Through the cooperation of the hatchery management one dozen hatching eggs each was obtained from 16 different supply flocks, none of which was located in Connecticut. These eggs were collected ten weeks after the first hatch which was suspected of having carried the disease directly to Connecticut farms. The yolks of four eggs were pooled to make three samples per dozen and were tested for the presence of both virus and neutralizing antibodies. In these tests, in contrast to other tests, no neutralizing antibodies were detected. From two yolk-pools originating in two different states, a virus was isolated and subsequently identified as that of Newcastle disease. Further inquiries along these lines were prevented by circumstances beyond the control of the authors.

The data presented on the occurrence of Newcastle disease in six shipments from the same hatchery left little doubt as to the hatchery being an important factor in the dissemination of the disease. This conclusion was supported by the fact that chicks already on the farm, proved susceptible, and that even after fumigation of the hatchery incubators and rooms, the disease broke out again in battery rooms. Among the possible avenues of entry into the hatchery figured the introduction of empty egg cases, the maintenance of a dressing plant, and the hatching eggs themselves.

**EXPERIMENTAL SPREAD OF NEWCASTLE DISEASE**

In order to follow the spread of Newcastle disease under simulated field conditions, 50 ten-week-old chickens were placed in groups of 5 into a ten-section battery. The birds were kept in an isolated house which was provided with Sterilamps and was within reach of hot water and live steam facilities. Preinoculation tests on 20 random serum samples were negative for Newcastle disease antibodies, which fact would indicate that the experimental stock had no prior experience with the disease.

After clinical observation for 3 days, 2 individuals of each five-bird group were inoculated by swabbing the laryngo-tracheal region with Newcastle virus in the form of allanto-amnionic fluid. The titer of the virus in embryonating eggs was $10^{-8}$. Tryptose-broth-dilutions containing $10^3$ and $10^6$ embryo m.l.d., respectively were inoculated into 10 birds each and another 15 birds each maintained as contact controls.

The clinical observations have been summarized in Table 3. It will be seen that in the $10^3$ group, the inoculated birds failed to exhibit symptoms, while of the contacts one bird showed respiratory symptoms on the 12th day postinoculation. On the other hand, in the $10^6$ group, 8 of the 10 inoculated birds showed symptoms between the 4th and 7th day, while only one contact bird showed late respiratory and nervous symptoms.

The serologic observations have been summarized in Table 4. A trial bleeding of 2 birds from each of the inoculated and the contact lots was made 11 days postinoculation with the result that the inoculated birds showed 1000 neutralizing doses while the uninoculated birds had none.

On the 20th day post-inoculation all birds were bled and subjected to complete quantitative neutralization tests. In the $10^3$ virus group, 9 of the 10 inoculated
birds and 5 of the 15 contacts showed antibodies of from 1000 to 1,000,000 neutralizing doses. In the 10^4 virus group, all 10 inoculated birds and 5 of the 15 contacts showed significant antibodies.

**Table 3.—Experimental spread of Newcastle disease. Number of birds showing first symptoms after intratracheal inoculation with or exposure to, Newcastle virus**

<table>
<thead>
<tr>
<th>DAY OF EXPERIMENT</th>
<th>$-3$ to $-1$</th>
<th>1 to 3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8 to 11</th>
<th>12</th>
<th>13</th>
<th>14 to 40</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 birds (10^8 m.l.d.)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>15 birds (contacts)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10 birds (10^5 m.l.d.)</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>15 birds (contacts)</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1*</td>
<td>-</td>
</tr>
</tbody>
</table>

* Nervous symptoms.

**Table 4.—Experimental spread of Newcastle disease. Number of birds showing various levels of neutralizing antibodies 20 and 40 days after inoculation with or exposure to, Newcastle virus**

<table>
<thead>
<tr>
<th>DAY OF EXP.</th>
<th>NEUTRALIZING DOSES IN SERUM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$10^5$</td>
</tr>
<tr>
<td>10 birds (10^3 m.l.d.)</td>
<td>20</td>
</tr>
<tr>
<td>15 birds (contacts)</td>
<td>20</td>
</tr>
<tr>
<td>40*</td>
<td>7</td>
</tr>
<tr>
<td>10 birds (10^5 m.l.d.)</td>
<td>20</td>
</tr>
<tr>
<td>15 birds (contacts)</td>
<td>20</td>
</tr>
<tr>
<td>40</td>
<td>7</td>
</tr>
</tbody>
</table>

* Total of 14 birds because 1 bird had died accidentally.

Comment: Of 20 birds tested prior to inoculation, all showed 10^5; furthermore 33 tests showing 10^9... on 20th or 40th day following inoculation or exposure, also indicate that the original experimental stock had no prior experience with Newcastle disease.

Of 2 birds per group subjected to trial bleeding on 11th day postinoculation, 4 inoculated birds showed 10^6, and 4 uninoculated birds 10^6, neutralizing doses.

The procedure was repeated on the 40th day postinoculation with the result that in the 10^4 virus group, 9 out of 10 birds reacted again but 5 with a higher titer, while 7 reacted in the contact group, i.e. 2 new ones and 5 with a higher titer. In
the $10^6$ group, the situation in the inoculated birds remained almost the same, while in the contacts the titer increased in 4 birds.

**SUMMARY**

Although one flock with significant serum neutralizing antibodies for Newcastle disease had been recognized in Connecticut in the winter of 1942/43, the first active outbreak, established by virus isolation, was observed in October 1945. Up to October 1946 a total of 65 cases have been diagnosed in the laboratory of which 2 represented cases in turkeys, 7 in different age groups on the same farms, and 56 represented affected chicken flocks. The diagnosis was established by clinico-pathologic examination in 8 cases, by serum neutralization test in 33, and by virus isolation in 24 cases. The average age at which the first symptoms appeared was 11 days in chicks, 81 in growing birds, and 270 days in adults. The average mortality in chicks was 23 percent, in growing stock 4 percent, and in layers 1.8 percent, accompanied in the latter instance by an average drop in egg production of 75 percent.

In a study of the probable spread of the disease, cases have been described which suggested interage-group transmission on the same farm, and this either from adult birds to chicks or from growing stock to chicks or adults. Other cases suggested spread from farm to farm, from breeder hatchery to chick customer, and from commercial hatchery to chick customer. Passive antibodies in chicks seemed to modify the course of the disease, when chicks from susceptible and immune sources were kept together.

In the case of the commercial hatchery five outbreaks occurred within 96 hours following receipt of the chicks on the premises. One of these farms was clean and depopulated when the chicks arrived, while three others had obtained chicks from another source which chicks later contracted the disease, thus showing susceptibility. The disease also made its appearance in battery chicks at the hatchery. This instance of hatchery dissemination appeared to be the first such recorded observation. Possible sources for introduction of the virus were egg cases, eggs, or adjacent dressing operations.

Several inapparent cases were detected by serologic methods. Evidence was obtained as to the inapparent spread of the disease on the same farm 2 to 3 months following an active outbreak.

The spread of the disease was followed experimentally in intratracheally inoculated and contact-exposed birds. When a small infective dose ($10^3$ embryo m.l.d.) was used, no clinical symptoms appeared but significant levels of neutralizing antibodies developed in the inoculated as well as the contact birds. When a larger dose ($10^6$ embryo m.l.d.) was used, clinical symptoms and neutralizing antibodies developed in the inoculated birds, but only antibodies in the contacts. A longer period of time was required for development of the titer peak in the case of the smaller virus dosage. Presence of $10^2$ and sometimes even $10^3$ doses of neutralizing antibodies indicated prior experience with the disease.

Passive immunity in chicks from previously infected parent stock and inapparent cases in any age group are believed to be largely responsible for the many now unexplained factors in the occurrence and the spread of Newcastle disease.
REFERENCES


WHAT INDUSTRY THINKS OF THE NEWCASTLE DISEASE PROBLEM

BY CLIFF D. CARPENTER, M.S., D.V.M.

President, Institute of American Poultry Industries, Chicago, Chairman National Committee on Newcastle Disease

It is no secret that the poultry industry was concerned last spring, when pathologists and state department officials made certain recommendations for the control of Newcastle disease which, if applied, would have meant serious business interruptions. Because of that concern, a National Committee on Newcastle Disease was suggested by industry in a spirit of helpfulness. It was conceived that, by thus affording industry the opportunity to counsel with state and federal agencies, practical programs of prevention and control of Newcastle disease could be initiated with a minimum of interruptions in the various poultry enterprises.

Since that time the National Committee has received widely publicized criticisms of its recommendations pertaining to the closing of live poultry shows and the disposition of egg laying contest entries. It should be pointed out that these recommendations were made by the Committee because live poultry shows and egg laying contests are the two outstanding instances in our industry where there is two-way traffic in live poultry, and whenever an infectious disease is present in a community, state or country, one essential in limiting the spread of that disease is the flow of vectors in one direction only. Thus, day-old chicks and pouls should flow to farms, and the finished broilers, roasters, fowl and turkeys should flow to market, thence to consumers, with no back haul.

To secure a fair sample of "what industry thinks of the Newcastle problem" representative individuals and industry groups were contacted, including poultry producers, hatcherymen, broiler producers, turkey growers, grain and feed dealers, and feed manufacturers, and asked for a brief statement regarding the Newcastle problem. Included in the returns were the following:

The American Farm Bureau Federation: "As you know, our National Poultry Committee devoted a considerable portion of their last meeting on August 7-8, 1946, to discussion of the need for study and control of Newcastle disease. The committee was in complete agreement with the recommendations of the National Committee on Newcastle Disease adopted on July 25. As evidence of such approval, they adopted those recommendations as their recommendations to the Board of Directors of the American Farm Bureau Federation. It was the committee's request that since the disease is now becoming prevalent throughout the country, all agencies be asked to cooperate in a program of control and eradication of this disease. These recommendations of our Poultry Committee were approved by the Board at its August 28-31, 1946, meeting."

Northeastern Poultry Producers Council—their Board of Directors passed a resolution in August, 1946 as follows: "Any state imposing a quarantine on flocks or hatcheries should give an indemnity to cover any loss resulting therefrom."

1 Presented at the U. S. Live Stock Sanitary Association Annual Meeting, December 4-6, 1946, Chicago, Illinois.
An Eastern Shore broiler representative (speaking personally): “The average hatcheryman on the Eastern Shore is scared to death of Newcastle disease since the outbreak reported to you yesterday. I presume the same is true of any broiler raisers who have heard about it—which means about all of them the way news usually travels on the Peninsula. The higher than usual mortality for the disease in this country has us all plenty worried. It may be that break we feared—let us hope NOT. The phone just rang. It was a call from an Eastern Shore of Virginia representative of a well known New England hatchery. He is plenty worried. It seems that the hatcheryman whose chicks came down with Newcastle accepted full responsibility and ordered the surviving chicks destroyed. This was a fine gesture but if anything in the nature of an epidemic occurred it could bankrupt a lot of hatcherymen. The point you have consistently made that indemnity should be provided by state or federal funds would seem to need invoking at this juncture.”

An R.O.P. breeder, officer of National Poultry Producers Federation (speaking personally): “I believe it is unfortunate that Newcastle disease has gotten into a controversial issue. Certainly if the livestock sanitary officials and the federal authorities as well as industry leaders had not taken any recognition of the disease and it had approached the virulence indicated in other countries, they would have been severely criticised. Certainly Newcastle disease is spreading rapidly throughout the entire country. Any poultry disease that is spreading as rapidly as Newcastle disease should have attention and preventive or corrective measures used as quickly as the information is available. Personally I believe that we shall have to develop vaccine that will control the disease. It seems to me that all possibilities for eradication without the slaughter of thousands and thousands of chickens is now impossible. Some years ago no doubt this disease could have been cleaned up on a slaughter basis.”

The Grain and Feed Dealers National Association: “We are very much interested in any program of poultry disease control, and especially so in the case of Newcastle disease. We feel we do not know enough about the problem yet, and will appreciate your committee keeping us informed. You may count on us in offering every possible assistance in helping to protect the country’s poultry flocks.”

International Baby Chick Association: “We are at least five years too late in attempting to fight Newcastle disease with quarantines of a state-wide nature. Poultrymen who have seen the disease and have had experience with it feel it is now something with which we must live. There has been no conclusive evidence—at any time—that infection is transmitted through the hatching egg. Great harm is being dealt to the hatching industry by persons in either public or semi-public office who even suggest that hatcheries are the source of infection. In general, the farmers and hatcherymen to whom I have talked don’t like the disease anymore than they appreciate any other poultry infection but they do not appear too alarmed. Hatcherymen, contrary to belief of some veterinarians, are quick to report to laboratories anything that looks like Newcastle disease and they DO NOT appreciate expressions such as were made in Washington by some veterinarians that hatcherymen would deliberately sell chicks known to be infected with pullorum disease. There is a general opinion that Newcastle disease undoubtedly exists in every section of the country.”

The National Turkey Federation: “The high degree of specialization in the turkey
industry and the isolation method of raising turkeys has prevented Newcastle
disease from becoming a serious problem to turkey people. However, turkey
people are anxious to reduce to a minimum, or to eradicate completely, the pos-
sibility of this infection ever gaining entrance to their flocks. As in the case of
poultrymen, they are especially interested in the development of standardized and
dependable vaccination procedures to meet emergencies when the infection is
present or when there is great danger infection might gain entrance into the flock."

California Poultry Council: "The industry recognizes that this disease has been
present on California farms for approximately ten years and that it has been known
to have appeared in flocks in all poultry producing areas in this state. The disease
seems to be more prevalent in chicken flocks than in turkey flocks. It seldom
appears as a recognized disease in turkeys. Although this disease is considered
important, it has not caused, except in a very few instances, great mortality or
economic losses and has had no sustained tendency to increase in severity. The
industry feels that there are other poultry diseases that are more serious than this
one and many industry people feel that they would rather have this disease than
several other so-called common diseases of poultry. This is particularly the view-
point of poultrymen in areas where the disease has existed for a considerable period
of time."

The Nutrition Council of the American Feed Manufacturers Association, Inc.:
"The Nutrition Council of the American Feed Manufacturers Association at their
meeting on December 2, 1946, expressed their opinion that the publicity on New-
castle disease has been out of proportion to the seriousness of the disease and that
the mortality from Newcastle disease has not been as great as it has been from a
number of other diseases that have been prevalent in this country for a number of
years. It is believed that the widespread publicity on Newcastle disease has been
definitely harmful to both the production and consumption of poultry and poultry
products, without any evidence of sufficient justification. In view of the above
statements, the Nutrition Council recommends the discontinuance of the Newcastle
Disease Committee and suggests that further investigation be carried on by estab-
lished state and federal agencies."

While it may be too early to evaluate the pros and cons of the work of the Na-
tional Committee on Newcastle Disease, at least "an aroused poultry public is an
informed poultry public" and it is probably fair to say that today the poultry
industry:

1. Is fairly well informed that Newcastle disease is present in a majority of the 48
   states,
2. Knows that the disease has existed at least in one state for several years,
3. Has been told, but perhaps is not convinced, that this disease is fully capable
   of causing extremely high morbidity and mortality,
4. Believes that, in general, the economic losses from this disease are lower than
   from some others of longer standing and better acquaintance,
5. Believes that our present knowledge of the disease is insufficient to impose
   general quarantine measures or embargoes,
6. Urges that all haste be made in appropriating federal and state funds to make
   available necessary buildings, equipment, and personnel to further needed
   research in this field.
7. Frankly states that more knowledge is necessary before any one focal point can be blamed for the spread of Newcastle disease.

8. Unfortunately does not present a united front concerning the need for an action program. For example, in some states poultry and hatchery associations recommended the closing of live poultry shows, others recommended against closing. Some apparently presume that because "nothing has happened, nothing will happen," while those who have experienced high morbidity or mortality obviously feel differently. It is regrettable that some industry representatives base their recommendations on their own limited experiences or on their own theories and beliefs, when the known scientific facts do not support such contentions.

Some industry representatives believe that the time has come for the formation of a broad national committee to analyze our entire poultry disease situation; that an overall poultry disease committee, patterned somewhat at least after the National Committee on Newcastle Disease, should be formed; that the personnel of this committee should be composed of representatives of federal and state agencies, educational and professional groups, and industry; that improved measures of sanitation should be employed in the production, procurement, processing and marketing of poultry and eggs, and that these measures should be extended to the processes of hatching, feed manufacturing and distribution.

Certainly it is not too early, and let us hope it is not too late, to initiate such an undertaking.

Let it be recorded here that industry greatly appreciates the opportunity of working closely with the Bureau of Animal Industry, the United States Livestock Sanitary Association, and state colleges, on the Newcastle disease problem. We believe that a better understanding of the problems of control have resulted from this association. Finally, it can be said that these public officials gave most generously of their time and efforts to the committee's program of work, and displayed an excellent understanding of industry's position. Such efforts properly coordinated and extended can do much more toward improving poultry viability than individuals and groups working separately.
THE PRESENT STATUS OF NEWCASTLE DISEASE IN THE UNITED STATES

BY DR. H. W. SCHOENING

Washington, D. C.

At a meeting of state veterinarians in Chicago last year, the subject of Newcastle disease was given considerable attention, with particular reference to the distribution of the disease.

The question was asked at that meeting, "Where does the disease exist?" At that time we had only a very limited amount of information. At a meeting in Washington, which was called by the Chief of the Bureau, to consider problems in connection with Newcastle disease, the same question was discussed at some length, and it was urged upon the participants of the meeting that all efforts should be made to establish diagnostic facilities so that we would have an opportunity of getting some idea of where the disease was.

We have quite a little information at the present time on the states wherein the disease exists, but we do not have very much information on the extent of the disease in many of these states.

According to our present information, virus has been isolated in the following seventeen states: Arkansas; California; Colorado; Connecticut; Delaware; Indiana; Kentucky; Maryland; Massachusetts; Michigan; Minnesota; Missouri; New Jersey; New York; Rhode Island; Virginia, and Wisconsin.

Serum neutralization tests indicative of past infection have been made in the following twelve states, as well as in several of those in the above virus list. The states are: Illinois, Iowa, Nevada, New Hampshire, New Mexico, North Dakota, Ohio, Pennsylvania, South Dakota, Texas, Utah and Washington.

Clinical diagnoses of the disease have been made in Oklahoma, at least.

According to our latest information, facilities for laboratory diagnosis have been provided or are being planned for in thirty-one laboratories in twenty-eight states. Those states in which facilities are presently available are: Alabama, California, Connecticut, Delaware, Georgia, Illinois, Indiana, Iowa, Kentucky, Massachusetts, Maryland, Michigan, Minnesota, Missouri, Nebraska, Nevada, North Dakota, New Jersey, New York, Ohio, Rhode Island, South Dakota and Wisconsin, a total of twenty-three facilities.

Those in which facilities are expected to be provided are: Kansas, Oregon, Virginia, Washington and Pennsylvania, a total of five.

It seems quite desirable to bring to your attention at this time that progress is being made in research on Newcastle disease, and you will be interested to learn the details of the meeting held in Baltimore on November 18-20 at the call of Dr. B. T. Simms, Chief of the Bureau of Animal Industry, to develop a national co-ordinative research program. Nineteen states were represented by poultry pathologists, and there were some state livestock sanitary officials present, and members of the Bureau of Animal Industry.
The various phases of the disease were discussed and plans of research were developed. Committees were formed and headed by chairmen, and these have consented to serve permanently. There will be an over-all committee composed of the chairmen of these various committees.

It is hoped through this research to have some of the answers to some badly needed problems in connection with the control of the disease.

At the conference on Newcastle disease held in Washington, D. C., May 2 and 3, 1946, the extent, diagnosis, modes of spread, methods of control, and other points in connection with the disease were discussed.

A National Committee on Newcastle Disease was established as a result of the Washington conference, and it was brought out at the conference and later meetings of the National Committee that there was urgent need for further information concerning certain aspects of the disease. The need for a coordinated research program was also discussed at the Washington conference. On this basis the Baltimore conference was called by the Bureau.

The following program for discussion of the various problems involved was outlined:

1. Purpose of meeting
2. The present extent of Newcastle disease in the United States
3. Diagnostic schools and facilities for diagnosis in the States
4. Consideration of a national research program
   a. Losses caused by the disease
      1. The present position of Newcastle disease in the United States with respect to its importance, (1) as such, and (2) in relation to other diseases.
      2. The need for collection of accurate information from the field in this respect. How can this be accomplished?
   b. Diagnosis of the disease
      1. Clinical
      2. Isolation of the virus
      3. Neutralization tests and significance
      4. Red cell agglutination and hemagglutination-inhibition tests, and significance
   Research program to be developed as might be indicated.
   c. The virus and its properties
      1. Filtrability
      2. Resistance to physical and chemical agents
      3. Virulence and modifications
      4. Susceptibility of species; distribution and fate of virus in chickens
      5. Preservation
      6. Age susceptibility
   Research program to be developed as might be indicated.
   d. Modes of spread of the disease
      1. Egg transmission
      2. Stage and duration of infectivity of infected birds
      3. Carrier birds, their incidence and practical importance in the spread of the disease
4. Infected premises and equipment
5. Personnel as a factor in spread

Research program to be developed as might be indicated.

e. Vaccination
1. Selection of most antigenic strains
2. Methods of preparation of vaccine
3. Laboratory test of vaccines (duration of immunity, etc.)
4. Field tests of vaccines
5. Development of a method of using vaccine in the field to control the disease in (a) broiler plant, (b) breeding flocks and laying flocks, alone, or in conjunction with other methods

6. Development of modified viruses and their use in vaccination programs
Research program to be developed as might be indicated.

5. Development of immediate program and possibly a long-time program.

a. Tentative immediate program for consideration
1. Field study of losses caused by disease
2. Resistance of virus
3. Modes of transmission
4. Carriers and importance
5. Vaccination
   a. Antigenic strains, methods, etc.
   b. Laboratory studies
   c. Field studies
   d. Development of methods of control

6. Experimental field control programs
7. Sanitary police measures of control

Final research program to be developed.

The conferees at the meeting were as follows:
Anderson, W. A., Pathological Division, BAI, USDA, Washington, D. C.
Baker, H. R., State Department of Agriculture, Dover, Delaware
Beaudette, F. R., Division of Poultry Husbandry, Agricultural Experiment Station, New Brunswick, New Jersey
Biester, H. E., Veterinary Research Institute, Iowa State College, Ames, Iowa
Brandly, C. A., Division of Veterinary Science, College of Agriculture, University of Wisconsin, Madison, Wisconsin
Brueckner, A. L., Live Stock Sanitary Service, College Park, Maryland
Bushnell, L. D., Department of Bacteriology, Kansas State College, Manhattan, Kansas
Byerly, T. C., Animal Husbandry Division, BAI, USDA, Washington, D. C.
Davis, C. R., Live Stock Sanitary Service Laboratory, College Park, Md.
Delaplane, J. P., Agricultural Experiment Station, State College, Kingston, Rhode Island
DeOme, K. B., Division of Veterinary Science, College of Agriculture, University of California, Berkeley, California
DeVolt, H. M., Division of Animal Pathology and Veterinary Science, Agricultural Experiment Station, College Park, Maryland
Dickinson, E. M., Department of Veterinary Medicine, Agricultural Experiment Station, Oregon State College, Corvallis, Oregon
Durant, A. J., Department of Veterinary Science, Agricultural Experiment Station, University of Missouri, Columbia, Missouri
Giltnner, L. T., Pathological Division, BAI, USDA, Washington, D. C.
Hall, W. J., Pathological Division, BAI, USDA, Washington, D. C.
Hamilton, C. M., Division of Veterinary Medicine, Agricultural Experiment Station, Puyallup, Washington
Hendershot, R. A., Chief, Bureau of Animal Industry, Trenton, New Jersey
Hofstad, M. S., Veterinary Research Institute, Iowa State College, Ames, Iowa
Jungherr, E. L., Division of Animal Diseases, Storrs Agricultural Experiment Station, Storrs, Connecticut
Levine, P. P., New York State Veterinary College, Cornell University, Ithaca, New York
Marston, Henry, ARA, USDA, Washington, D. C.
Moore, William, State Veterinarian, Raleigh, North Carolina
Moses, H. E., Division of Veterinary Science, Agricultural Experiment Station, Purdue University, Lafayette, Indiana
Moulthrop, I. M., Live Stock Sanitary Service Laboratory, Salisbury, Maryland
Mullen, F. E., Regional Diagnostic Laboratory, Virginia Department of Agriculture, Harrisonburg, Virginia
Osteen, O. L., Pathological Division, BAI, USDA, Washington, D. C.
Pomeroy, B. S., Division of Veterinary Medicine, Agricultural Experiment Station, University Farm, St. Paul, Minnesota.
Schoening, H. W., Pathological Division, BAI, USDA, Washington, D. C.
Shahan, M. S., Pathological Division, BAI, USDA, Washington, D. C.
Simms, B. T., Bureau of Animal Industry, USDA, Washington, D. C.
Stubbs, E. L., School of Veterinary Medicine, University of Pennsylvania, Philadelphia, Pennsylvania
Van Roekel, Henry, Division of Veterinary Science, Agricultural Experiment Station, Amherst, Massachusetts

The following summarizes the proceedings of the conference and outlines the important developments:

PRESENT EXTENT OF THE DISEASE IN THE UNITED STATES

Based on information received by the Bureau, it was reported that the disease had been diagnosed by means of virus isolations or serum neutralization tests, or both, in 29 States. Listed alphabetically, these States are: Arkansas, California, Colorado, Connecticut, Delaware, Illinois, Indiana, Iowa, Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Ohio, Pennsylvania, Rhode Island, South Dakota, Texas, Utah, Virginia, Washington, and Wisconsin.

Reports of clinical diagnosis of a disease of very suggestive nature have been received from Oklahoma, but laboratory confirmation has not yet been reported. Unconfirmed reports of clinical diagnoses in other States have been received. The
extent of the reported disease has varied in the several States, from one to three flocks involved in several instances to practically State-wide distribution in others.

**DIAGNOSTIC FACILITIES IN THE STATES**

Table 1 contains information as to facilities for laboratory diagnosis in the 19 States represented at the conference.

After general discussions of the subjects listed in the program (see pages 1 and 2), a committee was appointed for detailed consideration of each of the main items (4a, 4b, 4c, 4d, and 4e) on the program.

**LOSSES CAUSED BY THE DISEASE**

The committee considering losses caused by the disease (4a), was staffed as follows: T. C. Byerly, Chairman; H. E. Biester; A. J. Durant; I. M. Moulthrop; and C. M. Hamilton. This committee submitted the following outlined program for development of a system for accumulation of what has been generally agreed to be desirable, viz., comprehensive and accurate data on field occurrences of the disease:

1. The Bureau was urged to accept responsibility for collecting data on incidence and course of the disease through the State Livestock sanitary authorities and other agencies, and to compile and report these data periodically to the States. It was recommended that States in which infection is discovered in poultry shipped from another State should immediately report the facts concerning the occurrence to the proper authorities in the State of origin, sending a copy of the report to the Bureau.

2. The reporting authority in each State should submit to the Bureau periodic reports on the Newcastle disease situation in that State, the first report to give the status to date and the period covered. The reports should be rendered at least monthly in order to enable the Bureau to prepare and distribute a report for the country as a whole each month. The reports from the States should contain information on the following points: number of flocks affected, listed by county and State; method of diagnosis; number and kind of birds in each flock; origin of the stock birds; number of positive and negative tests; mortality from the disease; and status of each flock, i.e., whether the disease is incipient, at its height, or terminated at the time of the report.

3. In addition to the continuous reporting of occurrences of the disease, it was recommended that all presently available case histories be collected and analyzed. It was proposed that each diagnostic laboratory should undertake to furnish at least ten complete case histories during the remainder of the present fiscal year, each covering the following points: 1. location (county and State), 2. method of diagnosis, 3. kind, species, and age of birds (broiler, replacement, laying flock, breeding flock, etc.), 4. origin of stock (hatching eggs, hatchery, method of transport, age at delivery), 5. presumptive source of infection, 6. duration of outbreak, 7. number of birds in flock, 8. percent of flock affected (morbidity), 9. percent of sick that die (mortality), 10. prevailing symptoms (nervous, respiratory, effect on egg production), 11. other diseases or immunizations associated with the Newcastle disease outbreak, and 12. other remarks. A summary of the collected case histories should be published for the general information of the poultry industry, livestock sanitary authorities, and poultry diseases specialists.
## Table 1

<table>
<thead>
<tr>
<th>STATE AND INSTITUTIONS</th>
<th>PROVISIONS AVAILABLE FOR LABORATORY TESTS*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hemagglutination-inhibition test (HI)</td>
</tr>
<tr>
<td>California (U. of Calif., Div. Vet. Sci., Berkeley)</td>
<td>Yes</td>
</tr>
<tr>
<td>Connecticut (Agri. Exp. Sta., Dept. An. Diseases, Storrs)</td>
<td>Yes</td>
</tr>
<tr>
<td>Delaware (Agri. Exp. Sta., Dept. An. Ind., Newark)</td>
<td>Yes</td>
</tr>
<tr>
<td>Indiana (Purdue Univ., Dept. Vet. Sci., Lafayette)</td>
<td>Yes</td>
</tr>
<tr>
<td>Iowa (Iowa State College, Vet. Res. Inst., Ames)</td>
<td>Yes</td>
</tr>
<tr>
<td>Kansas† (Kansas State College, Div. Vet. Med., Manhattan)</td>
<td>No</td>
</tr>
<tr>
<td>Maryland (U. of Maryland, Livestock Sanitary Serv., College Park)</td>
<td>Yes</td>
</tr>
<tr>
<td>Massachusetts (Mass. State College, Dept. Vet. Sci., Amherst)</td>
<td>Yes</td>
</tr>
<tr>
<td>Missouri (Univ. of Mo., Dept. Vet. Sci., Columbia)</td>
<td>Yes</td>
</tr>
<tr>
<td>New Jersey (Agri. Exp. Sta., Dept. Poul. Husb., New Brunswick)</td>
<td>No</td>
</tr>
<tr>
<td>New York (N. Y. State Vet. College, Cornell U., Ithaca)</td>
<td>Yes</td>
</tr>
<tr>
<td>North Carolina (State Dept. of Agric.)</td>
<td>No</td>
</tr>
<tr>
<td>Oregon† (Oregon State College, Dept. Vet. Med., Corvallis)</td>
<td>No</td>
</tr>
<tr>
<td>Pennsylvania† (State Dept. Agri., Bureau An. Ind., Harrisburg)</td>
<td>No</td>
</tr>
<tr>
<td>Rhode Island (Agri. Exp. Sta., Dept. Poul. Husb., Kingston)</td>
<td>No</td>
</tr>
<tr>
<td>Virginia (Dept. of Agri., An. Dis. Lab., Harrisonburg)</td>
<td>Yes</td>
</tr>
<tr>
<td>Washington† (West Wash. Exp. Sta., Puyallup)</td>
<td>No</td>
</tr>
<tr>
<td>Wisconsin (U. of Wisconsin, Dept. Vet. Sci., Madison)</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* It is known that other States have provided, or plan to provide, laboratory facilities for the diagnosis of the disease. The Bureau has directed inquiries to the States not listed above in order that detailed information as to facilities throughout the country will be available.

† Facilities being prepared.
DIAGNOSIS OF THE DISEASE

The committee considering this subject (4b) was comprised of F. R. Beaudette, chairman; H. Van Roekel; W. A. Anderson; K. B. DeOme; M. S. Hofstad; and Wm. Moore. It was recommended that four problems, which follow in their order of relative importance, be studied. Experiment stations which agreed tentatively to work on the various phases of this program are listed.

1. A study of the time and rate of development, and the persistence of H.I. bodies is to be made by the California Agricultural Experiment Station.

2. An exchange of serum samples was proposed for critical comparative studies of the H.I. and S.N. tests. Agreeing to cooperate in this project were the experiment stations of California, Minnesota, Iowa, Wisconsin, Maryland, Indiana, New Jersey, and New York, as well as the Bureau.

3. The evaluation of the status of doubtful cases, which show low S.N. or H.I. titers, by the intramuscular injection of challenging doses of 10,000 m.l.d. of N.C.D. virus will be undertaken by the California, Minnesota, and Iowa experiment stations.

4. Under the problem of virus isolation, the possible necessity for blind passages, inoculation of chickens, and the effect of diluting autopsy tissues for inoculation are to be investigated at the New Jersey, Rhode Island, and Iowa experiment stations.

THE VIRUS AND ITS PROPERTIES

The committee considering this phase of the program (4c), consisting of H. E. Moees, chairman; E. L. Stubbs; J. P. Delaplane; E. M. Dickinson; and M. S. Shahan; classified the six items under this heading in the following order of immediate importance:

1. Resistance of the virus to physical and chemical agents was agreed to be indefinitely known under all conditions, and basic investigation of this matter, with both embryo- and chicken-propagated virus, was recommended as of first importance.

2. Susceptibility of species. It was recommended that this be investigated through neutralization and other tests to determine the antibody content of sera collected in the field from various species, both wild and domestic, and, including mammals as well as birds. Experiments were suggested under controlled conditions, wherein various species of unproved susceptibility might be placed in direct contact with artificially infected birds. The distribution and fate of the virus in chickens, as well as other species, were considered as of greatest importance in connection with the carrier problem and modes of spread of the infection.

3. Studies of various methods of preservation of the virus were presented as possible in most laboratories working with virus, either incidental to other work therewith, or in connection with studies of resistance to physical and chemical factors.

4. Studies of virulence and modifications of the virus were considered applicable chiefly in studies of immunization procedures.

5. Controlled studies of susceptibility of birds of various ages were considered desirable, but of less immediate importance than items 1 and 2, at least.
6. Filtration and purification studies were considered desirable, but not of major importance from the standpoint of present needs for information concerning control. Representatives of the following institutions expressed an interest in and probable ability to carry out work on one or more of the above outlined phases of research: The experiment stations of Indiana, Maryland, Minnesota, Massachusetts, Rhode Island, California, and New Jersey, Cornell University, and the Bureau. Other institutions were reported to be at present engaged in studies of this character.

MODES OF SPREAD OF THE DISEASE

E. L. Jungherr, chairman, P. P. Levine, B. S. Pomeroy, L. D. Bushnell and L. T. Giltner, on this committee, outlined the following experiments designed to yield definite information on modes of spread (4d):

1. Appropriate tests of eggs collected from natural outbreaks for the purpose of detecting virus by direct isolation and after hatching.
2 and 3. Tests of feces and respiratory secretions of chickens from a natural outbreak for virus.

Test infectivity by exposing susceptible birds to flocks at various intervals after natural outbreaks.

4(a) Test infectivity of depopulated premises by stocking with highly susceptible birds at various intervals and repeat the procedure on premises after usual cleaning.
(b) Test infectivity of standard crates after natural contamination by exposing susceptible birds to crates at various time intervals.

5(a) Test infectivity of workers' clothing at various intervals after handling infected birds, by direct contact with normal birds.
(b) Test longevity of virus in blood or other substances on clothing material at various time intervals by direct virus isolation.

The following institutions were tentatively placed on the list from which contributions in this field might be expected: The experiment stations of Connecticut, Massachusetts, California, Missouri, Minnesota, Indiana, Wisconsin, New Jersey, and Maryland, Cornell University, and the Bureau.

IMMUNIZATION

The committee on Vaccination (4e) as outlined in the original program, consisting of C. A. Brandly, chairman; W. J. Hall, H. R. Baker; F. E. Mullen; and O. L. Osteen, proposed to change the heading from "Vaccination" to "Immunization" since the latter terminology seemed to more fully cover the problems which were outlined as follows:

A. Inactivated Virus Vaccines
1. Selection of most antigenic strains of the virus (Repositories for representative strains proposed at California, Wisconsin and New Jersey experiment stations, and in the Bureau)
2. Methods for augmenting antibody response
3. Minimal standards for vaccine evaluation
4. Development of immunization procedures for experimental field control

B. Modified Virus Vaccines
1. Selection of strains
2. Methods of obtaining and maintaining satisfactory pathogenicity, immunogenicity, and safety.

3. In conjunction with inactivated virus vaccines

Tentative outlines for investigation of these problems were presented. At the final conference of the meeting, the following cooperators expressed a desire to take part in the procedures as follows:

A. Inactivated Virus Vaccines
   1. Experiment stations of California, Wisconsin, and New Jersey, and the Bureau
   2. California experiment station, and the Bureau
   3. California experiment station
   4. Experiment stations of California, Washington, Delaware, Maryland, Indiana, Massachusetts, and Minnesota, Cornell University, New Jersey Department of Agriculture, and the Bureau

B. Modified Virus Vaccines. New Jersey, Maryland, Rhode Island, and Wisconsin experiment stations, and the Bureau

EXPERIMENTAL FIELD CONTROL MEASURES AND SANITARY PROCEDURES

Repeated occurrences of this disease in shipped chicks have led to the incrimination of many hatcheries as possible means of dissemination of the infection. In part, at least, this may be due to the fact that all chicks originate in some hatchery. The evidence incriminating at least two hatcheries in separate States is however, overwhelming.

The committee on losses caused by the disease, T. C. Byerly, Chairman, suggested that information on the status of supply flocks with respect to infection, a complete description of the hatchery as to its usual sanitation program, a history of perhaps 100 lots of chicks sold, with identification as to supply flock of origin, should be obtained for a period of 4–12 weeks, among lots of chicks sold after an outbreak of Newcastle disease attributed to that particular hatchery. It was suggested that this program might well be effected by the State regulatory official in close cooperation with the poultry pathologist in the State.

It was suggested that selected case histories for the following classes of incriminated hatcheries be collected:

1. Hatcheries that have continued their usual sanitation and flock program without change.
2. Hatcheries which have inaugurated a rigid sanitation program subsequent to outbreaks of Newcastle disease in chicks sold.
3. Hatcheries which have inaugurated a rigid sanitation program, and which have systematically undertaken the diagnosis of Newcastle disease in their supply flocks and the elimination of the infected flocks.
4. Hatcheries which have continued their usual hatchery sanitation program but have attempted the systematic elimination of infected supply flocks.

Among the points which might be included in a rigid hatchery sanitation program, the committee suggested the following:

1. The hatchery room should be placed under quarantine so that admission would be granted only to hatchery operators and chick packers.
2. The hatchery room should be physically isolated by solid walls from all other rooms and provided with a separate ventilation system.
3. No chicks older than 24 hours should be kept in the hatchery room nor in the hatchery premises.
4. All hatchery wastes and offal should be sterilized, and the containers used to remove such materials should be sterilized following each use.
5. The hatchery should be thoroughly cleaned and the cleanings burned.
6. The hatchery should be disinfected with a solution of one pound lye per 15 gallons of water followed by compound solution of cresol, or equivalent, usually 4 ounces to the gallon of water. Incubators should be vacuum cleaned, and this should be followed by a triple strength fumigation, using 3 ounces of 40 percent formaldehyde and 1½ ounces potassium permanganate per 100 cubic feet, with high humidity for 24 hours.
7. Provision should be made for clean outer clothing, disinfected overshoes, and thorough washing of hands for every person entering the hatchery room at each such entrance.
8. All boxes, trucks, tables, equipment, and containers of all sorts in the hatchery should be disinfected.
9. A special room for receiving hatching eggs should be constructed, so that it may be cleaned and disinfected periodically, as provided for the hatchery.
10. Hatching eggs should be trayed and dipped in an appropriate solution of a quaternary ammonium compound, or chlorine solution in dairy strength.
11. Hatching egg cases should be identified and returned only to the farm of origin.

In order to evaluate management practices which may assist in the reduction of spread of infection, the committee suggested that the following information would be of value:

1. Selected case histories of premises on which Newcastle disease has been diagnosed should be prepared for farms on which an all-pullet program is practiced, as compared to farms on which both laying pullets and hens are maintained. Such case histories should describe the measures taken to assure the segregation of growing pullets from the laying flock.
2. The cleaning and disinfection procedures followed in preparing the house for a new generation of laying pullets after disposal of the previous generation.
3. The physical distance of the rearing facilities from the laying house.
4. The time of outbreak of Newcastle as to season and age of affected birds.

All data obtained should be reported directly to the Chairman of the committee on losses caused by the disease.

TERMINOLOGY

During the last day of the conference, a motion expressing preference for the term “Newcastle disease” rather than “avian pneumoencephalitis” was introduced. There was extensive discussion, followed by a vote of the conferees, which revealed a substantial majority favoring the motion. A part of the motion that was approved also directed that the matter of nomenclature be referred to the Committee on Nomenclature of Diseases, of the American Veterinary Medical Association, with the request that the matter be given immediate attention. This has been done by the Bureau.
ORGANIZATION AND METHODS OF PROCEDURE

Following receipt of the committees' reports and after a full discussion thereof, it was deemed advisable that an over-all committee be asked to serve in effecting coordination of the whole research program. Such a committee was appointed; the chairman of each of the five original committees, T. C. Byerly, F. R. Beaudette, H. E. Moses, E. L. Jungherr, and C. A. Brandly, agreed to serve on this committee under the direction of H. W. Schoening as chairman.

Byerly, as chairman of the group on losses caused by the disease, Beaudette, as chairman of the committee concerned with diagnosis, Moses, chairman of the section on the virus, Jungherr, heading the committee on modes of spread, and Brandly, as chairman of the committee considering immunology, will, through their various committees, set about development of definite suggested procedures for following out their respective projects. These outlined procedures will then be sent to each of the participating institutions, to the members of the committee directly concerned, and to the chairmen of the several other committees, including the chairman of the over-all committee. Upon completion of this phase, there will probably be a meeting of the over-all committee for a more thorough, general coordination of the program. As it becomes necessary, it is expected that meetings of those workers engaged in a common field of investigation will be called, in order that as direct collaboration as possible may be achieved.

Owing to the restricted facilities, it was impossible to invite conferees from every State. It is realized that several institutions not represented are already engaged in investigations of one phase or another of Newcastle disease, and that others are interested in and preparing for activity in this field. The fullest possible cooperation with any and all of these is earnestly solicited to the effect that a broad general knowledge may be obtained as soon as possible from as many angles as are practical. It is suggested that inquiries concerning the research program be addressed either to one of the Chairmen of the various primary committees or to H. W. Schoening, Chairman of the over-all committee.
REPORT OF COMMITTEE ON TRANSMISSIBLE DISEASES OF POULTRY


The past year has witnessed an unprecedented upsurge in the interest of the U. S. Livestock Sanitary Association and its members in the control of transmissible diseases of poultry. Today, at its 50th anniversary, it may be stated proudly that the Association is fully aware of its responsibility toward the two billion dollar poultry industry which, in turn, looks to this Association for leadership in disease control.

The enhanced activities of the Association, under the guidance and counsel of the Bureau of Animal Industry, have been concerned primarily with the spread of Newcastle disease through the northeastern and northcentral states, and with pullorum disease control the progress of which necessitates new approaches and reorientation from time to time.

In compiling the program for this occasion, your Committee on Transmissible Diseases of Poultry has made an effort to present topics which are of uppermost and immediate interest to both the industry and the livestock sanitarian, and to secure speakers for these discussions who are actively engaged in research work in these specialized fields. It therefore reds for the Committee report to give an account of the more important events not covered by the foregoing discussions in the field of poultry diseases, and to record the activities of the Association and its members in regard to the control of Newcastle disease.

**PULLORUM DISEASE**

The magnitude of the pullorum disease control program can be visualized only from a scrutiny of actual figures. According to recent data obtained through the courtesy of Mr. Paul B. Zumbro, senior poultry coordinator, in charge, National Poultry Improvement Plan, forty-seven states are now cooperating in the national plan for the control of pullorum disease in chickens, and thirty-six states in the corresponding plan for turkeys.

The number of chickens which have been tested officially for pullorum disease increased from 4,329,364 in 1935-36 to 21,098,026 in 1944-45, while the average percentage of first-test reactors fell from 3.66 to 2 percent for the respective periods. Furthermore, the maximum tolerance of reactors in the U. S. Pullorum-Tested class was gradually reduced during the past five years from "fewer than 10 percent" to "fewer than 5 percent" reactors.

During the past seven years there has been a consistent increase in the number and egg capacity of participating hatcheries. In 1945-46 there were 3,951 hatcheries with an egg capacity of 259,224,693 of which 374 with a capacity of 19,591,590 were rated as U. S. Pullorum-Passed, and 820 with a capacity of 26,684,494 eggs as U. S. Pullorum-Clean.
REPORT OF COMMITTEE

The figures for the U. S. Pullorum-Passed hatcheries have shown a consistent tendency to qualify for higher pullorum classifications in successive testing years. Concise data on chickens and turkeys officially tested for pullorum disease for the period from 1928 to 1944 have been published in Table 520 of U. S. Agricultural Statistics, 1945.

Among the new problems in pullorum disease control must be listed the question of the occurrence and importance of the so-called Canadian (Younie) or X variant of Salmonella pullorum in this country. The scientific aspects of the problem have already been presented to you by Drs. Edwards and Gwatkin. Cognizance has been taken of the practical aspects in a recommendation of the 1946 Conference of the National Poultry Improvement Plan, that steps be taken by the Bureau of Animal Industry to make available a polyvalent antigen or other antigen for the whole blood test which will satisfactorily detect carriers of all types of pullorum disease. It is not clear at present why the recommendation was limited to the whole blood test, in view of the fact that X-variant strains were first encountered in connection with birds that failed to react to the tube test.

Dr. R. R. Henley from the Pathological Division of the Bureau has already made a careful collation of the available information on X-variant strains in various laboratories in this country, and thus laid the groundwork for the formation of a Bureau policy on this problem. Further studies on this question, together with actual data on the application of X-variant containing antigens in problem flocks, will be watched with great interest by this Association.

That the spectrum of susceptibility to pullorum infection among the animal population may be wider than ordinarily realized, was indicated by the report of Edwards (7) on an outbreak in canaries. At the Storrs, Connecticut laboratory a similar outbreak was observed among young Bald Head Tumbler pigeons, which showed symptoms of incoordination, necrotic visceral lesions and microscopic evidence of severe meningitis. The diagnosis was established on bacteriologic grounds and the possible coexistence of ornithosis and Newcastle disease ruled out by appropriate tests. Earlier evidence of the possible pathogenicity of Salmonella pullorum for mammals was obtained by Benedict, McCoy and Wisnicky (2) who isolated the organism from infectious conditions in swine, foxes and mink, and by Edwards (8) who observed it in a calf affected with enteritis.

While Felsenfeld and Young (9) reported the occasional occurrence of Salmonella pullorum in man, Mitchell and his associates (12, 13) recently studied an extensive outbreak of gastroenteritis at an Army air base in Texas involving 423 persons of whom 172 required hospitalization. The source of the infection was traced to an egg-containing rice pudding that had been served at three successive meals. Salmonella pullorum was isolated from 11.7 percent of the hospitalized patients, in distinction from Salmonella derby in 0.6 percent, the only other significant organism encountered. This seems to be the first report of a large scale epidemic of human gastroenteritis presumably caused by Salmonella pullorum.

Other avian salmonelloses have received attention, particularly in regard to the possible occurrence of salmonella organisms in poultry products and dried eggs, according to Schneider (16). That salmonellae in chicken eggs may occasionally be responsible for human food poisoning was again attested by the report of Crowe.
Domesticated mammals may apparently be exposed not only from birds, as is well known, but also from reptiles, according to McNeil and Hinshaw (11).

A comprehensive survey for the period from 1933 to 1944 of avian salmonelloses in Great Britain was published by Gordon and Buxton (10). During the last three years of the survey, avian salmonelloses increased and were exceeded only by pullorum infection as a cause of fatal septicemia in young poultry. Chicks and ducklings were most commonly affected, and the occurrence of S. california, S. bareilly, S. montevideo, and S. anatum among poultry in Great Britain was reported for the first time. As the most probable source of these new types, the authors suspected processed egg material imported from America.

Attention again should be called to swine erysipelas in turkeys which was first reported in this country by Beaudette and Hudson (1) in 1937 and has since been found in many turkey-producing areas, particularly the Northeast and the Northwest. Recently Stiles (18) in Colorado reported outbreaks in turkeys and possible cases in man, and stressed, in this connection, the public health aspects of the disease. The Committee was also informed that Dr. E. P. Johnson of Virginia observed the disease in a flock of 20,000 ducks. It appears quite certain that swine erysipelas in birds occurs more commonly than is revealed through published reports, and that the disease must be counted among the economically important diseases of poultry potentially dangerous to man.

Although a discussion of the many-fold advances in chemotherapy would be too far-reaching and outside the province of this report, certain findings are of interest in here as indicating new weapons in the control of transmissible diseases of poultry.

For cecal coccidiosis, according to Thorp et al (20), the use of certain sulfonamides holds considerable promise as a means of prevention and control. In laboratory experiments Swales (19) showed the pyrimidine structure in a particular sulfa drug to be responsible for its coccidiostatic effect; he found sulfamerazine at the rate of 2 grams per pound of mash effective if given at the first sign of bloody droppings, while under farm conditions sulfaguanidinum showed definite value. These observations would suggest that coccidial chemotherapy for practical purposes is very promising but not subject to standardization at the present time.

In enteric infections, such as the newly recognized colibacillosis of poults, sulfathalidinid appeared to be effective, according to Scriver (17). Similarly, Mullen (14) ascribed a prophylactic effect to sulfamerazine in pullorum disease of poults. From controlled observations on salmonelloses Pomeroy and his associates (15) concluded that sulfonamides must be used with caution and are less effective in chicks than in poults, for pullorum disease and paratyphoid.

With regard to upper respiratory infections in chickens associated with Pasteurella avicida, the apparent efficacy of sulfaquinoxaline, as reported by Delaplane (6), is of interest since so far pasteurella organisms had been considered sulfa resistant.
From earlier papers on Newcastle disease and/or avian pneumoencephalitis, presented on the poultry programs of this Association and also from the wide publicity given the disease in the poultry press, the livestock sanitarian has become thoroughly familiar with this new problem confronting the poultry industry.

One feature that is not generally realized is its potential danger to man. As early as 1943 Burnet (3) reported a human infection with the virus of Newcastle disease in a laboratory worker, who came down with severe conjunctivitis, accompanied by febrile symptoms and the appearance of neutralizing antibodies in the blood. Later he (4) expressed the belief that this virus and other respiratory viruses of animals have the potentiality of becoming full-blown human pathogens. Recently Yatom (21) in Egypt observed, in conjunction with an outbreak of Newcastle disease in chickens, a localized epidemic of human conjunctivitis, particularly in farm women. The principal control measure consisted of removal of the infected birds.

Although the activities of Association members in the attempted control of Newcastle disease are known to many of you, a chronologic account which is a continuation of that given in last year's report may be desirable for the purpose of record.

During the last meeting of the U. S. Livestock Sanitary Association and the National Assembly of Chief Livestock Sanitary Officials, a special meeting was called for the discussion of Newcastle disease (avian pneumoencephalitis) at which your Committee was asked to incorporate instructions as to laboratory diagnostic procedures in the 1945 report.

On February 28, 1946 livestock sanitary officials and poultry pathologists of the northeastern states, together with representatives of the Bureau of Animal Industry, held a meeting in New York City, at the invitation of Dr. E. V. Moore, Assistant Commissioner of the Department of Agriculture and Markets, Albany, New York. The discussions at this meeting brought out the difficulties of attempting control on a state basis, and emphasized the regional nature of the problem.

On May 2 and 3 the first national conference on Newcastle disease was convened in Washington, D. C., under the auspices of the U. S. Department of Agriculture, Bureau of Animal Industry. In preparation for this conference the Chief of the Bureau sent "A Brief Discussion of Newcastle Disease" under date of April 19, 1946 ZM-1.206 to various representative poultry pathologists, state livestock sanitary authorities, and organizations and individuals in the poultry industry.

The first day of the meeting was devoted to technical questions, the second to practical discussions with representatives of the major segments of the poultry industry. The proceedings of this conference have been made available in mimeographed form to the conferees and other interested persons. The principal outcome of the meeting was the selection of a National Committee on Newcastle disease, designed to give representation to all major segments of the poultry industry.

The membership of this Committee, of which Dr. Cliff D. Carpenter is Chairman and Dr. T. C. Byerly Secretary, is as follows:

*Bureau of Animal Industry, Washington*

Dr. T. C. Byerly  
Dr. H. W. Schoening  
Dr. B. T. Simma
The National Committee on Newcastle Disease has held meetings at Chicago June 5, at St. Louis July 25, and at Washington, D. C. September 9 and 10, and is scheduled to hold a meeting at Chicago December 7 and 8. After meetings the recommendations of the Committee were sent to all state veterinarians, and over 600 poultry and egg processor plants and other members of the Institute of American Poultry Industries, while the press releases were supplied to heads of poultry departments in educational institutions, poultry pathologists of agricultural experiment stations, and poultry extension specialists. It may be seen that wide coverage was achieved of all interested individuals and organizations in the poultry industry.

Without detailing the various recommendations of the Newcastle Committee, which are a matter of public record, it should be stated that they were made with the intent of stopping the spread of the disease by agencies well known to this Association as potential hazards, such as poultry shows, egg laying contests, contaminated hatcheries, visitors, auctions, utensils, and so on. The Committee also suggested that all segments of the poultry industry in each state be invited to participate in drawing up voluntary control programs, and that regulations be promulgated only in the case of failure of the former. While the poultry industry at large reacted in an excellent spirit of cooperation toward these recommendations, vociferous protests and cries of discriminations have come from small interested groups against the ban of poultry shows.

From the standpoint of the livestock sanitarian, the recommendation is of importance as to the provision for adequate diagnostic facilities in each state, furthered by regional Newcastle disease schools for qualified persons. Such a school has already been held by the Department of Veterinary Science, University of Wisconsin, and the Division of Livestock Sanitation, Wisconsin Department of
Report of Committee

Agriculture, under the chairmanship of Dr. C. A. Brandly at Madison, August 15-16, 1946.

According to a communication 2M-1.206 of September 19, 1946 to state livestock sanitary officials, experiment stations and Bureau inspectors in charge, the Bureau of Animal Industry is in accord with the recommendations of the National Committee on Newcastle disease regarding the establishment of adequate diagnostic facilities in each state, and has distributed an outline of acceptable diagnostic procedures and equipment.

The Committee on Transmissible Diseases of Poultry, therefore, recommends to this Association to implement on a state basis these combined recommendations of the Bureau and the National Newcastle Committee.

References

8. Edwards, P. R.: Personal communication to authors of reference 12.


SALMONELLOSIS OF DOMESTIC ANIMALS

By D. W. Bruner, D.V.M., and P. R. Edwards, Ph.D.

Department of Animal Pathology, Kentucky Agricultural Experiment Station, Lexington, Kentucky

In May 1946 the records of the National Salmonella Center at the Kentucky Agricultural Experiment Station showed that 10,000 Salmonella cultures had been identified according to the Kauffmann-White schema (1) by the personnel of that center. These cultures were distributed among 106 serological types. They were isolated from 6,148 outbreaks of salmonellosis in 43 species of animals as well as from water, sewage, eggs, egg products, other food products and from some apparently normal animal carriers. Of the outbreaks listed above 3,482 occurred in fowls, 1,377 in man and 1,289 in other animals. In this report we are concerned with the 1,289 outbreaks in animals other than man and fowls. A few cultures isolated from reptiles and certain other animals usually not classed as domestic are included, since the majority of these animals were being held in captivity. With a limited number of exceptions the Salmonella cultures from domestic animals were isolated in the United States and were sent to this laboratory from all sections of the country.

Table 1 depicts the number of outbreaks of salmonellosis encountered in the various animal species listed. As stated above the data on fowls and man is not included. It also sets forth the number of Salmonella types found in each animal. In order to conserve space 2 animal species were combined under the heading “Other ruminants”, 2 under “Other carnivora”, 4 under “Other rodents”, 4 under “Reptiles” and 2 under “Lower primates”. Accordingly there were 23 animal species involved and they presented a total of 45 Salmonella types.

*S. abortus-equi* caused 27 outbreaks in horses and was most frequent in occurrence in this animal. *S. typhi-murium* was found on 14 occasions and *S. anatum* on one occasion. *S. typhi-murium* is capable of producing epizootics in foals without any other inciting cause and may appear in adult horses suffering from fatigue, exposure, or a diet inadequate in quality or quantity. It was observed in several instances following treatment of horses for intestinal parasites (2). *S. anatum* was isolated from the stomach exudate of a horse diagnosed as a “shipping fever” case (3). Recently Cordy and Davis described an outbreak of salmonellosis in horses and mules in India due to *S. bovis-morbificans* (4).

Eleven types of Salmonella were isolated from cattle. *S. dublin* appeared in 17 outbreaks and *S. typhi-murium* in 16. These two types accounted for more than 50 percent of the outbreaks and attacked calves more frequently than adult animals. However, enzootics occur among adult cattle where the causative agent appears to be a Salmonella type. Other types found were *S. paratyphi B*, 3; *S. derby*, 3; *S. anatum*, 4; and *S. dublin*, 17.

1 The investigation reported in this paper is in connection with a project of the Kentucky Agricultural Experiment Station and is published by permission of the Director. It was supported in part by a research grant from the U. S. Public Health Service.
S. bredeney, 1; S. cholerae-suis, 10; S. newport, 2; S. enteritidis, 5; S. pullorum, 1; S. worthington, 1 and S. minnesota, 1.

Six types were derived from 33 outbreaks in sheep. They consisted of S. paratyphi B, 4; S. typhi-murium, 20; S. bredeney, 1; S. cholerae-suis, 5; S. anatum, 2 and S. new-brunswick, 1. S. typhi-murium was isolated from a camel and S. derby from a deer.

Thirty-eight Salmonella types were isolated from 958 outbreaks of salmonellosis in swine. In fact only 8 of the 46 Salmonella types found in animals other than man and fowls were not obtained from swine and it is quite possible that continued typing will reveal the presence of many more types in pigs. Culturing of enteric lymph glands of apparently normal hogs also yielded numerous Salmonella types (5). S. cholerae-suis was isolated on 742 occasions from swine and in most cases was connected with hog cholera outbreaks where it appears to act as a secondary invader. Occasionally this microorganism is seen in sporadic cases of septicaemia in adult hogs in the absence of hog cholera and likewise in herds of young pigs where it may result in a high mortality rate. It frequently happens that virus diseases in swine predispose to Salmonella infection in these animals. S. typhi-murium caused 68 distinct outbreaks in swine, S. derby, 15; S. bredeney, 20; S. newport, 12; S. give, 10; S. anatum, 14 and S. worthington, 10. Other Salmonella types occurring in swine were less frequent in appearance and are not listed.

Four types were isolated from dogs. S. typhi-murium caused 9 outbreaks, S. cholerae-suis, 7; S. newport, 1 and S. anatum, 1.

Salmonella infection in foxes raised in captivity embraced 74 outbreaks. S. cholerae-suis appeared 28 times, S. dublin, 22 and S. typhi-murium, 17. Other types producing outbreaks were S. bareilly, 2; S. monterideo, 2; S. pullorum, 1 and

**Table 1.—Total outbreaks of salmonellosis and number of Salmonella types encountered in animals (fowls and man not included)**

<table>
<thead>
<tr>
<th>Source</th>
<th>Types</th>
<th>Outbreaks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horses</td>
<td>3</td>
<td>42</td>
</tr>
<tr>
<td>Cattle</td>
<td>11</td>
<td>60</td>
</tr>
<tr>
<td>Sheep</td>
<td>6</td>
<td>33</td>
</tr>
<tr>
<td>Other ruminants</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Swine</td>
<td>38</td>
<td>958</td>
</tr>
<tr>
<td>Dogs</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>Foxes</td>
<td>7</td>
<td>74</td>
</tr>
<tr>
<td>Other carnivora</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Rats</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>Mice</td>
<td>4</td>
<td>23</td>
</tr>
<tr>
<td>Guinea-pigs</td>
<td>4</td>
<td>29</td>
</tr>
<tr>
<td>Other rodents</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Reptiles</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Lower primates</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Total animal species, 23; total Salmonella types, 46; total outbreaks, 1289.
S. anatum, 2. Listed as "Other carnivora" were an outbreak of S. cholerae-suis in a cat and outbreaks of S. cholerae-suis, 2; S. newport, 1; S. bareilly, 1 and S. pullorum, 1 in minks.

S. typhi-murium was isolated from 6 outbreaks in rats; S. salinatis, 1; S. enteritidis, 9; S. anatum, 1 and S. newington, 1. In mice there were 6 outbreaks due to S. typhi-murium, S. enteritidis, 15; S. newport, 1 and there was 1 due to a non-motile Salmonella of somatic group B. In guinea-pigs S. typhi-murium was derived from 17 outbreaks, S. newport, 1; S. enteritidis, 9 and S. worthington, 2. Three outbreaks of S. typhi-murium occurred in rabbits and 1 outbreak of S. bovis-morbificans. Two outbreaks of S. typhi-murium appeared in muskrats, 6 in chinchillas and 1 in a coypu rat.

Table 2.—Total outbreaks and number of animal species infected by the 12 most commonly occurring Salmonella types

<table>
<thead>
<tr>
<th>SALMONELLA</th>
<th>ANIMAL SPECIES</th>
<th>OUTBREAKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. cholerae-suis</td>
<td>7</td>
<td>795</td>
</tr>
<tr>
<td>2. typhi-murium (aertrycke)</td>
<td>15</td>
<td>188</td>
</tr>
<tr>
<td>3. enteritidis</td>
<td>6</td>
<td>44</td>
</tr>
<tr>
<td>4. dublin</td>
<td>2</td>
<td>39</td>
</tr>
<tr>
<td>5. abortus-equis</td>
<td>1</td>
<td>27</td>
</tr>
<tr>
<td>6. bredeney</td>
<td>3</td>
<td>22</td>
</tr>
<tr>
<td>7. anatum</td>
<td>6</td>
<td>22</td>
</tr>
<tr>
<td>8. newport</td>
<td>7</td>
<td>20</td>
</tr>
<tr>
<td>9. derby</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>10. paratyphi B</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>11. worthington</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>12. give</td>
<td>1</td>
<td>10</td>
</tr>
</tbody>
</table>

Total animal species, 23; total outbreaks, 1212.

Among the reptiles there were 1 outbreak of S. san-diego in a tortoise; 2 of S. newport, 1 of S. oregon, 1 of S. panama and 1 of S. florida in snakes; 1 of S. manhattan in an iguana and 1 of S. anatum in a Gila monster. S. typhi-murium, S. meleagridis and S. rubislaw also were isolated from apparently normal snakes.

One outbreak of S. miami was observed in chimpanzees and 1 outbreak of S. paratyphi B, 1 of S. typhi-murium, 1 of S. enteritidis and 1 of S. rubislaw in monkeys.

Table 2 shows the total outbreaks caused by the 12 most frequently occurring Salmonella types and also lists the number of animal species in which each type appeared. S. cholerae-suis was the leading producers of salmonellosis. It was isolated on 795 occasions, of which 742 occurred in swine. Disregarding the swine isolations this type would be second to S. typhi-murium in number of outbreaks caused in the animals listed. It produced more outbreaks of salmonellosis in foxes than any other Salmonella type, was second to S. typhi-murium in dogs and sheep and was third in rate of incidence among cattle, where it caused 10 outbreaks. The ability of this microorganism to invade the tissues of mammals and produce septicemias which result in death long has been recognized.
SALMONELLOSIS OF DOMESTIC ANIMALS

*S. typhi-murium* demonstrated its ubiquity by appearing in 15 of the 23 animal species studied. This organism was found in 188 outbreaks of salmonellosis. It was the leading *Salmonella* type in sheep, dogs and certain rodents and was second in horses, swine, rats and mice. Since this bacterium is carried by such a wide variety of animals it is difficult to keep it from spreading to clean areas. It is a common infection of birds and like *S. pullorum* can be transmitted through eggs. In man this type is noted for its role in food poisoning outbreaks.

*S. enteritidis* produced 44 outbreaks. It ranks third in the types set forth in Table 2. Rodents accounted for 33 of these outbreaks, making the incidence of this type of less importance where other animals are concerned. It is distinctly a rodent infection. However, it is not the most common type found in rodents. That role is held by *S. typhi-murium*.

*S. dublin* produced 39 outbreaks of salmonellosis. Twenty-two of these appeared in foxes and 17 in cattle. Most of the cases in cattle were seen in calves, of which a few occurred in South America. This microorganism is notorious for its pathogenicity for calves in other parts of the world. It is noteworthy that in the United States *S. dublin* has not been isolated east of the Rocky Mountains.

*S. abortus-equii* caused 27 outbreaks of abortion in mares. No culture of this type was isolated from a mare in Kentucky within the past ten years. It has been incriminated in food poisoning in man.

*S. breedeney* ranks sixth in Table 2 and caused 22 outbreaks in 3 animal species, 20 of which occurred in swine. *S. anatum* was isolated from sheep, swine, dogs, foxes, rats and a Gila monster causing a total of 22 outbreaks. *S. newport* accounted for 20 outbreaks in cattle, swine, dogs, minks, mice, guinea-pigs and snakes; *S. derby* for 19 outbreaks in cattle, deer and swine; *S. paratyphi B* for 13 outbreaks in cattle, sheep, swine and monkeys; *S. worthington* for 13 outbreaks in cattle, swine and guinea-pigs and *S. give* for 10 outbreaks in swine. The remaining 34 *Salmonella* types and the number of outbreaks which they produced in the 23 animal species are listed as follows: *S. san-diego*, 2; *S. saint-paul*, 1; *S. california*, 1; *S. salinatis*, 1; *S. thompson*, 1; *S. oranienburg*, 2; *S. bareilly*, 7; *S. montevideo*, 3; *S. norwich*, 1; *S. bovis-morbiicans*, 1; *S. oregon*, 9; *S. manhattan*, 6; *S. panama*, 4; *S. miami*, 1; *S. pullorum*, 4; *S. meleagridis*, 1; *S. lexington*, 1; *S. newington*, 4; *S. new-brunswick*, 5; *S. illinois*, 1; *S. senftenberg*, 7; *S. rubislaw*, 1; *S. poona*, 1; *S. victoria*, 1; *S. mississippi*, 1; *S. florida*, 1; *S. cerro*, 2; *S. kentucky*, 1; *S. minnesota*, 1; *S. hormaechei*, 0; *S. urbana*, 1. A microorganism possessing the diagnostic formula, IV,V,XII . . . e h- was derived from one outbreak. Since it was impossible to isolate the second phase of this bacterium further identification was impossible. A non-motile organism of somatic group B (IV,V,XII . . . —) appeared in 2 outbreaks of salmonellosis and a non-motile member of somatic group C (VI,VIII . . . —) was found in 1 outbreak. Although *S. pullorum* is primarily a disease producer in fowls it was isolated from cattle, swine, foxes and minks. It was also found in gastro-enteritis in man. *S. paratyphi B*, especially the d-tartrate negative, diphasic form is the usual type found in enteric fever in man, whereas, d-tartrate positive strains were the more common types found in animals.

*Salmonella* infection in domestic animals may be grouped roughly into two general categories. There is the disease of equine abortion caused by a specific Sal-
Salmonella type. On the other hand there are the infections of a septicemic nature characterized by weakness, recumbency and increased temperature. Brain symptoms and convulsions were observed in some cases in calves and adult cattle. Diarrhea is usually one of the accompanying symptoms. The latter type of outbreak occurs most frequently and apparently can be caused by any one of the 46 Salmonella types obtained from animals. Records of isolations show that outbreaks of salmonellosis are more common in young animals and that the mortality in these animals exceeds that of adults. It is primarily a disease of immature animals, but frequently appears in debilitating conditions of both young and adult animals. Salmonellosis may assume a septicemic condition in man and in lower animals, but frequently a state of gastro-enteritis occurs in man, whereas, the former is the usual form in animals. The diagnosis of salmonellosis in domestic animals is based chiefly upon the isolation and identification of the microorganism. Feces of a living or dead animal are placed in tetrathionate broth (6), incubated for 24 hours and plated on phenol red-brilliant green agar (6). Direct cultures are made on plain infusion agar from organs of dead animals. Growth from the plain infusion agar or from pink colonies on the brilliant green agar is identified by agglutination with diagnostic serums or is tested on appropriate sugars and then checked serologically. Suspected Salmonella growth will be agglutinated by a polyvalent anti-Salmonella serum and usually will not produce indol, nor ferment lactose, sucrose, or salicin.

SUMMARY

Forty-six Salmonella types were found in 1,289 outbreaks of salmonellosis in 23 animal species not including man and fowls. With the exception of S. abortus-eguï these microorganisms produced so-called paratyphoid infections in domestic animals which generally were more severe in the young animals than in adults.

REFERENCES

ESTIMATING LIVESTOCK LOSSES

By A. V. Nordquist

Agricultural Statistician, Livestock and Poultry Statistics Division, United States Department of Agriculture

For many years the Department of Agriculture has published estimates of livestock losses. Since 1924 the estimates have been prepared in connection with the balance sheet accounts of livestock numbers where items of increase or decrease are determined for the purpose of estimating production of, and subsequently income from, meat animals. It might be stated that in this project the concern with livestock losses has been a secondary consideration, the primary emphasis being placed on the total pounds produced and the total dollars received by farmers from the sale of farm animals. But in the process of ascertaining production and income, livestock losses had to be determined as one of the items in a balance sheet of livestock numbers. To make a production estimate for a given species of livestock it is necessary to know the inventory number at the beginning and end of the year, the number of imports and births during the year, as debit items, and the number that were sold, slaughtered by farmers, or that died during the year, as credit items.

For most of the balance sheet items, some check information is available. The inventory numbers are checked against the Federal Census enumerations made every five years. The Census enumerations record the number of animals on farms as of certain dates. Estimates of outshipments and local slaughter are checked against the records of livestock received at public markets and by packers. Railroad shipments and records of livestock inspected under health or brand regulations are also used. The Federal Census records the number of head of livestock slaughtered on the farm for home use or for sale as meat which serves as a benchmark for estimates made for farm slaughter. No check data is available for all States on the births of livestock. However, in some important livestock States, the State Farm Censuses which are taken every year provide annual information on the number of sows farrowing and on births of certain species.

There is, however, no independent information on livestock losses. Questions relating to losses have not been included in the Federal Census, and have not been carried in any of the State Censuses, except in Colorado. Livestock losses, therefore, must be estimated from information obtained from surveys of livestock producers without benefit of independent data that can be used as a check.

The fact remains that because of the vast amount of dependable check information obtained on the other items of the livestock balance sheet, the individual estimates of livestock losses are thereby improved. If reliable estimates are made for the inventory numbers, the livestock births, sales, slaughter, and inshipments, the balance sheet, itself, tends to establish a good estimate of livestock losses. To illustrate: If the number of all hogs on farms in a given State on January 1 at the beginning of the year was 5 million head, the pig crop 7 million head, and the number shipped into the State for breeding and feeding 50,000 head, the total available
number for disposal would be 12,050,000 head. If 6 million remained on farms at the end of the year, 5 million were sold, shipped out, or slaughtered locally, and 300 thousand slaughtered on farms, the known number on hand or disposed of would be 11,300,000 head. The losses, then, would be the difference between the total available for disposal, amounting to 12,050,000 head, and the 11,300,000 head disposed of or still on farms, or 750,000 head.

For the meat animals—hogs, cattle, and sheep—the records of slaughter that are available for the U. S. more or less establish within certain limits the size of these livestock enterprises, especially when the January 1 inventory numbers are known. With the level of farm slaughter established by Census enumerations, and the imports into this country known, the main concern is with the number of births and the number of deaths. The Federal Census furnishes periodic information on the number of breeding animals which provides the benchmarks for the estimates of cows over 2 years old, ewes, and sows farrowing. So, in reality, the concern is with the birth rate. The births must be large enough to account for the disposition, and the deaths evidently cannot be estimated at a level so large as to result in an unreasonable number of births in relation to the number of breeding animals. These are the practical considerations in the problem.

Balance sheets for livestock are prepared by States for each species. For some States there is a wealth of independent check information on market receipts, births, inshipments, and slaughter. For some States, the records of livestock movements are fairly complete because marketing patterns by State of origin are easily traced and records of these movements readily obtainable. In other States the pattern is more complex, and it is difficult, if not impossible, to trace the livestock movements. Direct movement by trucks in and out of States where inspection is not required or records are not kept serves to illustrate the difficulty. In States where check information is lacking, the estimates for the balance sheet items are primarily based on information obtained from the livestock surveys. That is to say; the estimates of births, deaths, farm slaughter would be based on sample data and the estimates of marketings and local slaughter would be derived. Where inshipment, marketing, and slaughter data were dependable and complete, it could be assumed that the estimates of births and deaths were also fairly well in line with the actual situation if it were definitely known.

Information on livestock losses is obtained directly from farmers, who voluntarily report on the January 1 Livestock Disposition Schedule and other special schedules sent to them by mail. The January 1 Livestock Disposition Schedule is used in all States, except the Western States. In the Western States, special schedules are used for sheep and cattle to secure information on the numbers on hand, and questions on livestock losses are included on these schedules. The Livestock Disposition Inquiry which is used in most of the States is mailed out in late December of each year. It includes questions on the number of livestock on hand, the number of breeding animals, births, farm slaughter, and deaths of livestock. For example, for cattle the items covered are: (1) The number of all cattle and calves on this farm, January 1; (2) the number of all cows and heifers 2 years old and over; (3) the number of calves born; (4) the number of cattle which died on the farm during the year; (5) the number of calves which died on the farm during the year; (6) the
number of cattle butchered on or for the farm during the year; (7) the number of calves butchered on or for the farm during the year. Similar questions, appropriate to the species, are asked for hogs and sheep. For horses and mules the questions cover the number on hand, the births, and the deaths.

Over the past 5 years between 65 and 80 thousand farmers returned schedules each year. When filled out, the schedules are forwarded to the State Statistician's office in each respective State where they are reviewed, edited, tabulated, and summarized by Crop Reporting Districts and for the State. Death rates are computed from the summaries.

To illustrate the present procedure used in preparing the estimates, the steps taken for the estimates of deaths of all hogs and pigs are outlined briefly. From the summary the reported number of deaths of all hogs and pigs is divided by the reported number of pigs born to obtain the ratio of deaths to pigs born. This ratio is applied to the estimate of the pig crop to obtain an indicated number of deaths. A chart is prepared showing the indicated deaths plotted against the estimated deaths for a series of years. The relationship of the indicated deaths to estimated deaths over the past years helps determine the current year's estimate. The number of deaths derived through the chart interpretation is fitted into the balance sheet for hogs. It may be necessary to change the figure to some extent in either direction, depending on how well the balance sheet for hogs works out. If, as mentioned before, some items of the balance sheet are not supported by a complete and dependable record, the death loss estimate as such is considered to be as good as any of the other items and is accepted. But modifications are necessary where items such as marketings, inshipments, and slaughter are based on complete and fairly accurate records for the individual State.

This procedure boils down to estimating the yearly change in losses, since the level of estimates of losses has been established by considering all of the evidence for all of the items of the balance sheet. In some States and for some species there is little difference between the level of the estimates and the level of the number of deaths indicated by the sample. In other cases, the estimates are on a somewhat different level than figures obtained from the sample indications. The sample data for some States is subject to bias. Since a mailed inquiry is used, and voluntary reports are solicited, a random sample is not obtained even though some controls can be exercised in the distribution of the sample within a given State. It has been found generally that crop and livestock reporters tend to be better than average farmers. Yields reported from their farms tend to be higher than the average for their respective areas. They adopted hybrid corn at a faster rate than occurred in their localities. It might be reasoned, therefore, that livestock reporters would have fewer losses than the average for their areas. In general, this appears to be the case, but it is not always clearly indicated because of bias due to selectivity of the sample or other reasons.

It is important to note that the indications on losses are derived from reports on the number of deaths, and not on the judgment appraisal of the extent of losses in the community in terms of numbers lost or that died per 100 head. Many years ago, the Department of Agriculture sent out an inquiry about the first of May each year to crop correspondents asking them for the death losses of the different
species of livestock from disease and exposure per 1000 head during the year ending April 30. This report extended over a period of about 35 years. The published information showed the death rate per 1000 head and the total deaths separately for those lost through exposure and those lost from disease. Detailed studies made of these figures revealed that they were of considerable value as indexes of livestock deaths from year to year, but were not dependable indications of actual death losses. Part of the difficulty was due to the nature of the questions asked. These related only to deaths from exposure and deaths from disease, with no provision for obtaining the deaths from other causes—accidents, old age, etc.—which always have formed a large proportion of the total losses. It was difficult to determine the nature of the replies to questions of this kind. What was the reporter’s concept of losses and what did he use as a base to express his losses per 1000 head? With livestock numbers changing every day of the year, due to births and disappearance, it would be difficult for the farmer to ascertain a base and practically impossible for the statistician to determine a comparable one. There would always be the question as to whether the number per 1000 head ought to be applied to the January 1 inventory, the births, the sum of both to arrive at actual losses, or to some other figure. The computed figures, however, used the January 1 inventory number as a base.

These judgment estimates, however, tended to reflect the year to year changes in losses. In judgment replies a tendency prevails to overemphasize the abnormal losses and not to register the minor changes in losses from year to year.

The Department has not wholly abandoned the judgment inquiry on losses. At present, the range and livestock reporters in the Western States are asked their opinion on losses of cattle and calves and sheep and lambs each year. This information has proven valuable in noting the effects of feed shortages and severe weather upon livestock numbers. The indications tend to agree with other indications as to the relative change between years though generally are not considered as dependable as the information obtained from the larger samples of individual farm losses.

During the period 1920 to 1923, the Department obtained information each month on the number of livestock on hand, births, purchases, sales, farm slaughter, and deaths. This information was obtained from about 7,500 crop and livestock reporters. It was the first effort made to include all losses and to obtain the information on an individual farm basis. There was no breakdown to show losses from different causes. The results of this experiment, however, pointed to the need for using reports on individual farms and ranches rather than judgment estimates on locality losses, and to the need for obtaining total losses, rather than just the losses from disease and exposure. The monthly survey was later supplanted by the January 1 Livestock Disposition Inquiry which is in use at the present time.

The estimates of death losses in the United States show a greater difference in the number of losses than in the death rates. In general, the number of the death losses depends to a large extent on the size of the population of livestock. The death rates for the U. S. for a given species do not vary widely. Over the past 5 years, the death losses of horses have been declining. The death rate is not much changed, ranging from 5.0 percent in 1945 to 5.7 percent in 1941. The continued decline in horse numbers is reflected in the declining number of deaths. The death
losses for mules have held fairly constant but the death rate seems to be at a somewhat higher level in the last two years than in the earlier years. Mule losses have ranged 42 head per thousand in 1941 to 48 in 1945. Cattle deaths reached 1,674,000 head in 1943 which was the highest of the period. The death rate per 1000 head on hand January 1 shows little change between years for the U. S. and only moderate changes for the Regions but there are variations between the different sections of the country. The South Atlantic States show the largest number lost per 1000 and the West North Central States show the smallest. The death rate of calves shows more variation between these years and between the different Regions than is the case for cattle. Hog losses reached a peak in 1943 when deaths were set at nearly 15 million head. This was the year of the record pig crop. The loss estimates exclude most of the death loss of pigs before weaning age. Death rates for hogs are highest in the Southern States and lowest in the Corn Belt. Sheep losses have been declining as the numbers on hand have been reduced. The rates vary by Regions, being the highest in the North Atlantic and Western States. For the U. S. the lamb deaths per 1000 head of lambs saved are at a somewhat higher level than the death rate for sheep. In 1945 losses for sheep and lambs were estimated at about 6,000,000 head. The death loss statistics by Regions and for the U. S. for the period 1941-1945 are shown in the Appendix.

In recent years there has been an increasing interest in losses of livestock. This interest has centered on losses due to different causes. People interested in disease control, predatory animals, farm management, and other phases of the livestock industry have found need for more information on losses. Available statistics on losses due to specific causes are fragmentary and generally local in character. Studies have been made and results published by the Experiment Stations on losses from shipping livestock and on bruising, deaths and crippling of livestock. Stockyard records have provided some of the background information on this score.

In the last few years, several of the State Statistician offices have collaborated with the State Veterinarian’s office or the Fish and Wildlife Service, Division of Predator and Rodent Control, to conduct surveys on the nature of death losses of livestock and poultry. In 1944, three States—North Dakota, South Dakota, and Nebraska—conducted surveys to determine losses due to coyotes and other predatory animals. In North and South Dakota the surveys related strictly to losses from coyotes. In Nebraska the survey covered losses from other predators including dogs, and losses from all other causes. The schedules used asked for inventory numbers of livestock and poultry, losses and estimated value of the losses. Schedules were mailed to a random list of livestock producers. The data provided two indications on losses—the number lost as a percentage of the number on hand and the average loss per livestock farm. The first indication was expanded to a total for the State by multiplying by the State estimate of the inventory number for each species. The second indication was expanded by multiplying the average by the number of livestock farms in the State. The estimates prepared from these data showed losses due to coyotes were valued at a little over $3,000,000 for the 3 States in 1944. In Nebraska, however, the losses from coyotes were only a small fraction of the value of total losses which was set at $20,000,000. This was based on the estimated value placed on these animals by the reporter.
Two other States made cooperative surveys of losses. In Missouri, a survey covering losses from July 1, 1943, to June 30, 1944, was undertaken. In Wisconsin, the survey was taken in January 1, 1945, and related to losses in 1944. In both States, the questionnaires were designed to pick up losses from specific causes. The losses were segregated into three main groups, namely, losses from predatory animals, losses from diseases, and other losses.

In Missouri, losses from predatory animals were further segregated to show specific losses due to foxes, wolves, coyotes, dogs, and other predatory animals. Reporters were invited to list the various diseases resulting in death and also the measures they were taking to reduce losses. They were asked to recommend measures to reduce death losses. The Missouri report showed the percentage of total losses reported under each of the causes for the various species of livestock.

Table 1.—Missouri: proportion of losses from various causes

<table>
<thead>
<tr>
<th>CLASSES</th>
<th>DISEASE</th>
<th>PREDATORS</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>percent</td>
<td>percent</td>
<td>percent</td>
</tr>
<tr>
<td>Cattle over 6 months</td>
<td>38.7</td>
<td>1.3</td>
<td>60.0</td>
</tr>
<tr>
<td>Calves</td>
<td>59.4</td>
<td>4.4</td>
<td>36.2</td>
</tr>
<tr>
<td>Sheep over 6 months</td>
<td>30.5</td>
<td>42.2</td>
<td>27.3</td>
</tr>
<tr>
<td>Lambs</td>
<td>26.8</td>
<td>37.4</td>
<td>35.8</td>
</tr>
<tr>
<td>Hogs over 6 months</td>
<td>39.2</td>
<td>32.0</td>
<td>28.8</td>
</tr>
<tr>
<td>Pigs</td>
<td>42.0</td>
<td>20.6</td>
<td>37.4</td>
</tr>
<tr>
<td>Chickens over 3 months</td>
<td>51.7</td>
<td>33.1</td>
<td>15.2</td>
</tr>
<tr>
<td>Chickens under 3 months</td>
<td>54.1</td>
<td>27.2</td>
<td>18.7</td>
</tr>
<tr>
<td>Turkeys over 3 months</td>
<td>47.9</td>
<td>29.6</td>
<td>22.5</td>
</tr>
<tr>
<td>Turkeys under 3 months</td>
<td>47.6</td>
<td>39.0</td>
<td>13.4</td>
</tr>
</tbody>
</table>

and for chickens and turkeys. It was also possible to list the diseases reported but not in order of importance. The results of the Missouri survey are shown in Table 1.

In Wisconsin the inquiry was sent to crop and dairy correspondents. Replies were received from about 2,500 reporters. This information was summarized and published in the May 1945 issue of "Wisconsin Crop and Livestock Reporter", a bulletin prepared by the Wisconsin Federal-State Crop Reporting Service. The Wisconsin schedule did not obtain separate losses caused by individual predatory animals as was the case for the Missouri inquiry. All losses from predatory animals were combined. The number lost through disease was also obtained and comments supplied by reporters gave some indication of the most common causes. Losses by accident, old age, theft, and other causes were also requested as was the average value per head of animals lost. The results of the Wisconsin survey are shown in Table 2.

Probably the most detailed survey ever undertaken on a State-wide basis in connection with determining causes of losses was the Wyoming Livestock Loss Prevention Survey of January 1, 1942, which covered the year 1941. The results of this survey are shown in a mimeographed publication issued in August 1942. The
survey was made by the Vocational Agriculture and Research Services, Wyoming State Department of Education, in cooperation with 34 Chapters of Future Farmers of America. The questionnaire was prepared and sent to each F.F.A. Chapter requesting that the information called for be secured by boys in the local chapters. Each member reported for his home farm or some other farm or ranch from which he could secure the detailed information. Replies represented a total of 718 farms. This survey is of interest because of the large amount of detailed information that was developed from the returns. No effort was made to expand the indications to a total for the State of Wyoming. With reservations, it was believed to be a fair cross-section by the specialist who prepared the statistics. The data was summarized to show the actual reported number of losses and the percentage that these losses were of the total for a given species. In addition to the summary for losses,

<table>
<thead>
<tr>
<th></th>
<th>DISEASE</th>
<th>PREDATORS</th>
<th>ACCIDENT AND OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>percent</td>
<td>percent</td>
<td>percent</td>
</tr>
<tr>
<td>Cattles over 6 months</td>
<td>64.0</td>
<td>.5</td>
<td>35.5</td>
</tr>
<tr>
<td>Calves</td>
<td>79.9</td>
<td>1.4</td>
<td>18.7</td>
</tr>
<tr>
<td>Sheep over 6 months</td>
<td>42.1</td>
<td>29.6</td>
<td>28.3</td>
</tr>
<tr>
<td>Lambs</td>
<td>40.0</td>
<td>33.5</td>
<td>26.5</td>
</tr>
<tr>
<td>Hogs over 6 months</td>
<td>73.0</td>
<td>2.6</td>
<td>24.4</td>
</tr>
<tr>
<td>Pigs</td>
<td>59.6</td>
<td>4.8</td>
<td>35.6</td>
</tr>
<tr>
<td>Chickens</td>
<td>69.2</td>
<td>16.8</td>
<td>14.0</td>
</tr>
<tr>
<td>Turkeys</td>
<td>48.1</td>
<td>30.8</td>
<td>21.1</td>
</tr>
</tbody>
</table>

The report recorded the type and causes of injuries to livestock and the farm or ranch practices and shipping practices having a bearing on livestock losses. The number reporting these different practices were also shown. Another section of the report was devoted to diseases observed on the farm and the number of farms reporting these diseases.

The type of information that has been gathered has proven quite suitable for certain needs. The data have served as a guide in the operations of State agencies who are concerned with livestock diseases and predatory animal control. The statistics have pointed out the relative importance of losses from different causes and provided some indication of the value of livestock lost.

It is only natural that one would question the accuracy of this type of information, especially the ability of a reporter to determine the exact cause of death. Perhaps some deaths from exposure were actually the result of disease. Perhaps some losses attributed to accidents were primarily due to infection. In many cases, however, reporters had the benefit of veterinarian services and reported accordingly. It would be possible to check the extent to which reporters gave their own diagnosis or used that of a veterinarian by asking for that kind of information on the inquiry. The project undertaken at the Iowa State College may throw some light on this question.
<table>
<thead>
<tr>
<th>REGION</th>
<th>DEATH LOSS (THOUSAND HEAD)</th>
<th>DEATH RATE (NUMBER PER 1000 HEAD*)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1941</td>
<td>1942</td>
</tr>
<tr>
<td>Horses and colts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. Atlantic</td>
<td>48</td>
<td>45</td>
</tr>
<tr>
<td>E. N. Cent.</td>
<td>128</td>
<td>113</td>
</tr>
<tr>
<td>W. N. Cent.</td>
<td>205</td>
<td>170</td>
</tr>
<tr>
<td>S. Atlantic</td>
<td>29</td>
<td>28</td>
</tr>
<tr>
<td>S. Cent.</td>
<td>115</td>
<td>97</td>
</tr>
<tr>
<td>Western</td>
<td>88</td>
<td>74</td>
</tr>
<tr>
<td>U. S.</td>
<td>612</td>
<td>527</td>
</tr>
<tr>
<td>Mules and mule colts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. Atlantic</td>
<td>2.6</td>
<td>2.5</td>
</tr>
<tr>
<td>E. N. Cent.</td>
<td>7.5</td>
<td>6.2</td>
</tr>
<tr>
<td>W. N. Cent.</td>
<td>15.3</td>
<td>14.8</td>
</tr>
<tr>
<td>S. Atlantic</td>
<td>43.6</td>
<td>42.6</td>
</tr>
<tr>
<td>S. Cent.</td>
<td>99.9</td>
<td>98.1</td>
</tr>
<tr>
<td>Western</td>
<td>3.0</td>
<td>2.8</td>
</tr>
<tr>
<td>U. S.</td>
<td>171.9</td>
<td>167.0</td>
</tr>
<tr>
<td>Cattle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. Atlantic</td>
<td>101</td>
<td>98</td>
</tr>
<tr>
<td>E. N. Cent.</td>
<td>220</td>
<td>235</td>
</tr>
<tr>
<td>W. N. Cent.</td>
<td>475</td>
<td>414</td>
</tr>
<tr>
<td>S. Atlantic</td>
<td>123</td>
<td>137</td>
</tr>
<tr>
<td>S. Cent.</td>
<td>392</td>
<td>375</td>
</tr>
<tr>
<td>Western</td>
<td>247</td>
<td>275</td>
</tr>
<tr>
<td>U. S.</td>
<td>1,457</td>
<td>1,534</td>
</tr>
<tr>
<td>Calves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. Atlantic</td>
<td>306</td>
<td>319</td>
</tr>
<tr>
<td>E. N. Cent.</td>
<td>412</td>
<td>450</td>
</tr>
<tr>
<td>W. N. Cent.</td>
<td>534</td>
<td>572</td>
</tr>
<tr>
<td>S. Atlantic</td>
<td>127</td>
<td>139</td>
</tr>
<tr>
<td>S. Cent.</td>
<td>426</td>
<td>420</td>
</tr>
<tr>
<td>Western</td>
<td>340</td>
<td>383</td>
</tr>
<tr>
<td>U. S.</td>
<td>2,145</td>
<td>2,283</td>
</tr>
</tbody>
</table>
### Table 3.—Continued

<table>
<thead>
<tr>
<th>REGION</th>
<th>DEATH LOSS (THOUSAND HEAD)</th>
<th>DEATH RATE (NUMBER PER 1000 HEAD*)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1941</td>
<td>1942</td>
</tr>
<tr>
<td>Hogs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. Atlantic</td>
<td>170</td>
<td>230</td>
</tr>
<tr>
<td>E. N. Cent.</td>
<td>2,318</td>
<td>3,132</td>
</tr>
<tr>
<td>W. N. Cent.</td>
<td>3,325</td>
<td>4,871</td>
</tr>
<tr>
<td>S. Atlantic</td>
<td>939</td>
<td>1,177</td>
</tr>
<tr>
<td>S. Cent.</td>
<td>1,757</td>
<td>2,192</td>
</tr>
<tr>
<td>Western</td>
<td>395</td>
<td>459</td>
</tr>
<tr>
<td>U. S.</td>
<td>8,904</td>
<td>12,061</td>
</tr>
<tr>
<td>Sheep</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. Atlantic</td>
<td>73</td>
<td>68</td>
</tr>
<tr>
<td>E. N. Cent.</td>
<td>363</td>
<td>378</td>
</tr>
<tr>
<td>W. N. Cent.</td>
<td>543</td>
<td>511</td>
</tr>
<tr>
<td>S. Atlantic</td>
<td>93</td>
<td>85</td>
</tr>
<tr>
<td>S. Cent.</td>
<td>1,233</td>
<td>1,043</td>
</tr>
<tr>
<td>Western</td>
<td>1,921</td>
<td>1,989</td>
</tr>
<tr>
<td>U. S.</td>
<td>4,226</td>
<td>4,074</td>
</tr>
<tr>
<td>Lambs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N. Atlantic</td>
<td>49</td>
<td>48</td>
</tr>
<tr>
<td>E. N. Cent.</td>
<td>309</td>
<td>358</td>
</tr>
<tr>
<td>W. N. Cent.</td>
<td>752</td>
<td>789</td>
</tr>
<tr>
<td>S. Atlantic</td>
<td>85</td>
<td>79</td>
</tr>
<tr>
<td>S. Cent.</td>
<td>944</td>
<td>637</td>
</tr>
<tr>
<td>Western</td>
<td>1,058</td>
<td>1,065</td>
</tr>
<tr>
<td>U. S.</td>
<td>3,197</td>
<td>2,976</td>
</tr>
</tbody>
</table>

*Horses and colts: Number per 1000 head on farms Jan. 1 and colts raised during the year. Mules and mule colts: Number per 1000 head on farms January 1 and mule colts raised during the year. Cattle: Number per 1000 head on farms January 1. Calves: Number per 1000 head of calves born. Hogs: Number per 1000 head of all hogs and pigs on farms January 1 and total pigs saved during the year. Sheep: Number per 1000 head of stock sheep on farms January 1. Lambs: Number per 1000 head of lambs saved.

It will be noted that since 1941 a movement toward obtaining more information on livestock losses has taken place. With the exception of the Wyoming survey, these surveys have been conducted under cooperative arrangements between State and Federal agencies. Agricultural Estimates, the organization of the U. S. Department of Agriculture which has the responsibility of collecting basic data on
agriculture, has not been provided with the facilities to conduct a nation-wide program for obtaining statistics on livestock losses from various causes. Such progress as is made along these lines in the various States, under the present circumstances, must result from cooperative efforts of State and Federal agencies. The existing facilities of the State offices are a limiting factor to rapid progress in attaining information on losses on a broad scale and at regular intervals. A few State projects are in the formative stage at present and may be undertaken if necessary arrangements can be made.

A nation-wide survey on livestock losses from different causes and on livestock diseases in the detail required to meet all needs would be faced with many problems if a high degree of precision is desired. The problems involved in sampling are not as formidable now as they were several years ago. Much experience in enumerative sampling has been gained in recent years, and sampling schemes can be designed in much less time than formerly required. But there are difficulties in connection with determining causes of death losses, determining the extent of diseases or measuring the effects of disease control that have not been experienced in sampling for other items like the number of workers on farms or the number of acres of crops. The difficulties will be greatest in determining the causes of losses and the diseases of sheep and cattle on the Western ranges where it is often difficult for the rancher to know exactly the number of head he owns and the number that were lost, let alone what the causes were. There are other equally difficult problems that arise out of the wide variation in livestock practices that exist in this country. There will need to be some experimentation to determine the maximum amount of reliable information that can be obtained at a reasonable cost.

Perhaps the broad provisions of the Flanagan-Hope Bill on marketing research would permit allocation of some of these funds for expanding the studies on livestock losses and their causes. Livestock losses do tie in very definitely with the marketing of livestock.
A SOLID FOUNDATION FOR VETERINARY SCIENCE

BY M. S. SHARAN, D.V.M.

Pathological Division, Bureau of Animal Industry, United States Department of Agriculture, Washington, D. C.

Organized veterinary medicine in the United States is almost a hundred years old. The current meeting marks the fiftieth anniversary of this association of livestock sanitarians. During these years so much has been accomplished that if one were to recount the progress step by step to another, not a member of the profession, he would doubtless blush from the sense of immodesty. None would say however, that all problems and difficulties have been solved, or that the methods employed in the past should necessarily be continued without alteration.

In the erection of a building, a bridge, or a dam, the architects and engineers frequently spend more time in planning the structure than in erecting it. The most careful calculations are made, over and over again, in connection with materials, design and techniques. The merit of these procedures becomes apparent in the strength, stability and beauty of the product. Planning there has been in veterinary medicine and it has unquestionably brought us a long way, but it must be recognized that there is no one perpetually infallible plan in the field of science.

And if we as veterinarians are to progress in the field of science, our analysis, approach and execution must be scientific. Fortunately this philosophy is subscribed to by the leaders in our profession today, and there is hope, much hope, for the future.

RESEARCH

Research, which may be defined simply as a systematic study of phenomena by experimental methods, may also be said to be the bedrock of any progressive science. This has certainly been true in veterinary science. If we are to progress, it will continue so. We cannot deny, however, that strictly veterinary research has lagged behind the needs in recent years. In many fields, our knowledge has not kept pace with the need for facts upon which to base sound disease control measures. We may be proud that our American Veterinary Medical Association has undertaken the collection among members of the profession of a fund with which to initiate a comprehensive research program, and incidentally to supply at least a part of the scientific background that so much needs development. Regulatory officials, as well as practitioners and others, should realize how important is research, if it is properly incorporated into the basic structure.

EDUCATION

The required period for an acceptable veterinary education has progressively increased from the originally required two years, to three, then to four, and now five and six years. Education was conceived originally to play an essential part in the development of a real science of veterinary medicine. Today, in the face of more critical demands for truly scientific service, education standards are being con-
stantly revised and raised to higher and higher levels. The concept that the basic function of the veterinarian is to \textit{prevent} disease in animal populations, rather than to \textit{treat} individual animals, is gaining widespread recognition. The teaching of ethics and a sense of responsibility in rendering economic service, and the instillation of a truly scientific spirit are now common objectives in the curricula of most of our educational institutions. Attention is being given to additional facilities for postgraduate training and, wisely, more opportunities are being provided for research on the part of the teaching staffs. In short, veterinary education is progressing, and there is every reason to believe that this foundation substance will support its huge portion of the weight of the superstructure. A pressing problem at the moment is the provision of adequate facilities for training of the large number of students seeking a veterinary education. Before passing on, however, we should not forget that the education of the livestock man himself is an essential part of the support for sound veterinary science. At present, it appears questionable that even our broadly applied agricultural extension service is performing this function adequately.

\textbf{A BROAD BASE}

Even with a sound stratum for our foundation, we must be assured of its breadth and general strength, if we are to continue construction confidently. In our present considerations, this may be taken to include all that is applicable from other broad fields of science, whether this involves biology, chemistry, physics, zoology, genetics, nutrition, mathematics, or even climatology. This is an age of specialists and in building our foundation, let us not ignore that fact, and avail ourselves whenever need be of the services of any specialized personnel trained in techniques adaptable to our problems.

The broad interests of veterinary science must include all species of animals, whether helminths, arthropods, birds or mammals. Potential reservoirs or carriers of infection, may be discovered in wholly unsuspected places. More and more frequently, the lower animals are being found to be sources of infection for man. We must be versed in public health developments. In the inspection of meat and milk, the veterinarian has almost countless opportunities for control of \textit{animal} as well as human disease. In considering this breadth of scope and almost universal adaptability of veterinary science one could continue indefinitely.

\textbf{STATISTICS}

In the opinion of the writer, no one constituent of our complex foundation would be of more importance than a systematized collection of factual data on the incidence of disease, whether heritable, infectious, or environmental. Such data should be considered as a most important component of sound veterinary science.

Strangely enough the need for such information has been repeatedly stressed, still without any workable system having been developed to date. One of our most highly respected colleagues, Dr. L. Van Es, stated in effect years ago, that one launching on a program of control of a disease without knowledge of the incidence and distribution of that disease was as a sailor on an uncharted sea. The A.V.M.A. has had an active committee on vital statistics for several years; the Livestock
Sanitary Association's present Committee on Miscellaneous Transmissible Diseases has been especially active.

The time seems ripe for some definite, immediate action along this line. Before proceeding with any considerations of policy and procedure, however, it probably would be well to review some past events.

The Office Internationale des Epizooties was founded in 1924 for the purpose of setting up a central world-wide agency for information on distribution and extent of epizootic diseases. This organization functioned very well until the war and has recently been revived with more than 40 countries participating. It publishes regularly a statistical review of the disease situation in the cooperating countries and issues an annual bulletin which contains a record of proceedings of the meetings held by the delegates, together with special articles, reports and laws and regulations pertaining to control of disease and importations. For certain technical reasons, the United States has never become a member of this organization, which performs a generally useful function of great importance to livestock sanitary authorities in all countries. It so happens that the governments of the member countries are generally highly centralized, whereas we have here 48 individual, quite independent units with which to deal. While our system of reporting would necessarily be more complex than in countries with more centralized organization, there is no reason to believe that this could not be worked out effectively, in the U. S. A.

The fact that numerous committees and organizations in the United States have been concerned with the problem of collection of disease statistics has been pointed out. No country in the world has a more worthwhile record than ours in the control of bovine tuberculosis. The records on this activity are most comprehensive. In the same way, considerable information has been acquired on the incidence of brucellosis, at least in cattle. Data on most other diseases are quite incomplete. One exception is equine encephalomyelitis on which data have been collected on a voluntary basis for the past 12 years. The records give a reasonably accurate picture of the situation with respect to this disease, and should serve to encourage those interested in a more inclusive program. In recent years, data on rabies have been accumulated, but only on an annual basis.

In 1944, the special Committee on Vital Statistics, of the A.V.M.A., accumulated a mass of comprehensive data on the facilities and practices of the various State livestock sanitary authorities relative to the reporting of disease by practicing veterinarians and others. It was determined that many States had laws or regulations making the reporting of certain diseases mandatory, but that some had neither rules nor laws to effect this. No penalties for failures to comply were provided in many States, and some defined failure as a misdemeanor, subject to fines amounting to as much as $500, or jail. In at least one State there was a provision allowing for revocation of license. This committee compiled quite comprehensive but not burdensome lists of suggested reportable diseases occurring in horses, cattle, sheep, swine and fowl.

In the opinion of many with years of intimate experience among busy practitioners, one of the major impediments in the development of a Nation-wide, comprehensive system for reporting on the incidence of disease is the lack of appreciation by the average practitioner of the over-all value of such data. Still others feel
that at least some of the State officials themselves would not cooperate. The Bureau's experience in encephalomyelitis indicates that generally this would not be true and in any event cooperation on the part of all concerned could be developed eventually. However, there is unquestionably a place for a well-considered program of education in this field, beginning with the student and extending into all branches of the veterinary and livestock fields.

The importance of diagnostic facilities in any program of collection of disease statistics was appropriately outlined before the 1945 meeting of this association by your Committee on Miscellaneous Transmissible Diseases. Just who should provide these facilities is an important matter for decision. Lack of diagnostic facilities has recently been emphasized in connection with diseases of poultry, especially Newcastle disease. Through cooperative effort, provisions for handling diagnosis have been made or are in preparation in about two thirds of the States. There can be no question as to the need for diagnostic centers capable of covering the entire field of animal diseases. It would seem, however, that this is a matter that comes under local jurisdiction and should be developed by the States, whether in the laboratories of the colleges, the experiment stations, or the departments of the executive branch of the government.

The major responsibility for a successful disease statistics program, it seems to the writer, lies with the regulatory officials in the States, individually and collectively. It is to their special advantage and to the distinct benefit of their livestock producers that they know exactly what diseases are incipient or prevalent, and where they exist, at all times. If this association were to formulate and initiate a sound program, and here is where it should begin, in the writer's opinion, there is no sound reason for belief that the Bureau would not cooperate to the fullest extent of its ability.

It seems inevitable that there must be eventually a comprehensive and fully adequate system for reporting of diseases. Eradication, control, or prevention of animal disease is the basic job of most of those in attendance at these sessions. If a workable plan for accumulating data on disease cannot be devised by the many talented individuals affiliated with this Association, together with the support of others favoring the basic principle, it probably never will be done at all.
THE FATE OF 4 GR./LB. BODY WEIGHT OF 7 SULFONAMIDES IN 7 ANIMAL SPECIES

BY MARK WELSH, C. R. SCHROEDER, DELIA F. VRovMAn, LESTER REDDIN, ROBERT BURKHART AND PETER LANGER

Lederle Laboratories Division, American Cyanamid Company

The treatment of bacterial disease with specific chemotherapeutic agents—the sulfonamides—marks a new era in medicine.

The sulfonamides, the wonder drugs, had their birth in medical application in 1932 when the work of the German chemist, Domagk, was publicized. He introduced prontosil—a compound originally synthesized for the dye industry. It was found to be ineffective in vitro but protected mice against infection with hemolytic streptococci. It was found that the compound was broken down in the mouse, the dye radical liberated, and the basic compound Sulfanilamide shown to be the active bacteriostatic agent.

Wood and others in England showed that this new compound was different from other drugs in its action. It apparently substituted for para amino benzoic acid in the respiration of the bacterial cell and prevented its growth and multiplication. It has since been shown that sulfonamides are toxic substitution or competitive products for growth factors other than para amino benzoic acid as well.

French, English, Swiss, and American chemists, notably those in the employ of Merck & Company, Sharp & Dohme, Parke Davis, and American Cyanamid Company in this country, and Imperial Chemical Industries in England are now screening thousands of compounds to learn whether they are (1) bacteriostatic, (2) toxic to the animal body, or (3) can be economically made.

The field is just opening; new compounds appear daily as antibacterial agents, antimalarials, filaricides, antiseptics, and disinfectants, all with entirely new principles of activity.

Effective compounds may have no practical use unless they can be made available for field use at a reasonable cost to the practitioner. Only those compounds which can be made from readily available inexpensive raw materials will have practical use. The manufacturing chemist must devise methods of preparation to bring about low-production cost so that the final product can be used economically in the field.

The program begins with the synthesis of the compound by the research chemist using a test tube and flask, and, if the compound shows promise, progresses to the pilot plant, moves on finally to the production kettles in the manufacturing units where volume production reduces unit cost.

In the process of evaluation or screening, drugs are first studied in vitro by trying varying concentrations against a variety of bacterial genera in P.A.B.A.-free media.

If a compound is found to be effective at low concentration in vitro, its toxicity, including its lethal dose for 50% of a group of experimental animals used, (usually mice) known as the L.D. 50, must be determined. Its bacteriostatic activity in vivo is then determined.

213
The chick embryo has been used extensively to study in vivo activity, but here the dose of drug remains in the host since it cannot be excreted.

There is an advantage, however, in being able to use large numbers of embryos to overcome biological variance and permit the presentation of an honest statistical picture.

The mouse, rat, rabbit, monkey, dog, and baby chick are likewise used extensively.

Methods employed to determine sulfonamide levels (concentration) in urine, blood, and stools are concerned with complex chemical reactions—specifically diazotizing the sulfonamide or coupling the sulfonamide with a radical which will give the newly formed compound color. The intensity of the color, which forms slowly, is in direct proportion to the amount of sulfonamide present in the blood sample.

A group of color standards are made using the sulfonamide for which we are testing. The blood sample is laked, reagents added, and levels determined by comparison with the known standards in a colorimeter. These procedures can be set up in most laboratories but are impractical for the everyday use of the practicing veterinarian. The Lignin test is simple for the determination of the presence of sulfonamides. Place a drop of the patient's urine on a piece of woodpulp paper (paper towel, toilet paper, newspaper; but not filter paper). Add a drop of 5% hydrochloric acid. If a sulfa drug has been taken, a yellow color appears immediately which, on standing, deepens to orange. This color response occurs within 45 minutes to 1 hour after the first ingestion of a sulfonamide and remains positive up to 60 hours after the last dose. The presence of as little as 0.01% of a sulfa drug gives a positive response. The LaMotte Company has prepared a compact sulfonamide-blood level determination unit that is proving to be entirely acceptable.

The method used in this study for determining sulfonamide concentration in blood and milk follows:

The reaction in this method depends on the presence of an amino group substituted in the benzene ring and for any derivative of sulfanilamide in which the amino group is free or can be free by hydrolysis.

The method consists of diazotization of the p-amino benzene sulfonamide with nitrous acid and coupling the resulting diazo compound with N-(1-naphthyl)-ethylenediamine dihydrochloride to produce a purplish-red color which can be determined colorimetrically.

**REAGENTS**

1. Saponin solution containing 0.5 Gm./liter.
2. Trichloracetic acid solution—15 Gm./100 cc. distilled H₂O.
3. Sodium nitrite solution—100 mg./100 cc. distilled H₂O (freshly prepared each week).
4. Ammonium sulfamate solution containing 0.5 Gm./100 cc. distilled H₂O.
5. N-(1-naphthyl)-ethylenediamine Dihydrochloride solution containing 100 mg./100 cc. of distilled H₂O (keep in dark bottle). Reagents 3, 4, and 5 should not be made up in amounts larger than 100 cc. because of their tendency to deteriorate.
6. 4N HCL.
7. Stock solutions of sulfonamides—200 mg./liter.
Dilute standards were prepared as follows:

- 5 cc. of stock solution diluted to 100 cc. = 1 mg. % standard
- 10 cc. of stock solution diluted to 100 cc. = 2 mg. % standard
- 15 cc. of stock solution diluted to 100 cc. = 3 mg. % standard
- 20 cc. of stock solution diluted to 100 cc. = 4 mg. % standard

1-20 dilutions of above standards were made using
- 2 cc. standard solutions
- 30 cc. distilled H₂O
- 8 cc. trichloracetic acid solution

Ten cc. aliquots were used in duplicate and reagents added as for unknown samples. Blank was made with 8 cc. distilled H₂O plus 2 cc. trichloracetic acid solution and solutions read in Coleman spectrophotometer at wave length 545.

Standard curve is plotted from these readings.

Standard curves were prepared using sulfadiazine, sulfaguanidine, sulfathiazole, and sulfamethazine. Values for sulfanilamide, sulfapyridine, sulfamerazine, and sulfathalidine were obtained by reading from one of the above standard curves and correcting with appropriate conversion factors based on the molecular weights of the compounds.

**PROCEDURE FOR BLOOD**

Dilute 8 cc. oxalated blood with 30 cc. of saponin solution or distilled H₂O (saponin solution not necessary in dilutions greater than 1-10). Add 8 cc. of 15% trichloracetic acid with shaking.

Let stand 10-15 minutes and filter.

This represents a 1-20 dilution.

A 1-10 dilution using saponin was made where concentrations of drug were suspected of being low.

Subsequent dilutions from a 1-20 dilution were made using trichloracetic acid diluent (1 part 15% trichloracetic acid and 4 parts distilled H₂O) where drug concentrations were found to be high.

**FREE SULFONAMIDE**

10 cc. aliquot in test tube in duplicate.

Add 1 cc. sodium nitrite solution, mix, let stand 3 minutes.

Add 1 cc. of sulfamate solution, mix, let stand 2 minutes.

Add 1 cc. of N-(1-naphthyl)-ethylenediamine dihydrochloride solution.

Mix and let stand 10 minutes for optimum color development.

**BLANK**

8 cc. of distilled H₂O or 8 cc. of pooled blood filtrates.

2 cc. of 15% trichloracetic acid.

Add reagents as above substituting 1 cc. of distilled H₂O for sodium nitrite solution.
TOTAL SULFONAMIDE

10 cc. of filtrate + 0.5 cc. of 4N HCl.
Heat in boiling water bath for 1 hour.
Cool and adjust volume to 10 cc.
Add reagents as for free sulfonamide determinations.

**Table I.**—Kidneys—A typical pathology protocol indicating usual histological findings in the kidney following overdosage

Experiment: Cpd. 477; type of animal: monkey

<table>
<thead>
<tr>
<th>ANIMAL NO.</th>
<th>TECHNIQUE</th>
<th>Nephritis</th>
<th>Nephritis</th>
<th>CALIBER</th>
<th>CASTS</th>
<th>RENAL CORPUSCLES</th>
<th>ARTERIES</th>
<th>INTER. STIT</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>RM 3</td>
<td>frozen</td>
<td>*</td>
<td>many dil., in t, m, and p</td>
<td>(a) drug precipitates with leucocytes</td>
<td>(b) prot</td>
<td>(c) leucocytes alone</td>
<td>leuco-cytes around casts</td>
<td>*partial necrosis of wall of tightly plugged tubules</td>
<td></td>
</tr>
</tbody>
</table>

Regions are indicated as follows: c = cortex, t = transitional zone, m = medulla, p = papilla.


*Interpretation:* Mechanical injury by precipitation of drug in the lumen of tubules, resulting in compression of epithelium of dilated tubules and accumulation of leucocytes around the aggregates of drug crystals. No evidence of chemical injury to tubules or renal corpuscles.

Chemotherapy Division, Stamford Research Laboratories, American Cyanamid Company.

Samples were read in Coleman spectrophotometer at 545 wave length, using blank to set the zero reading.

Standard curves were made using 10 cc. aliquots of 1–20 dilutions from 1, 2, 3, and 4 mg. per 100 cc. standard solutions.

Concentrations in mg. per 100 cc. could then be read directly from standard curves.

Corrections were made for any change in aliquots or dilutions.

It was found necessary to make some modifications of above method.
This protocol shows the inability of Sulfanilamide to control Gram-negative infection. The dose is equivalent to 1 grain per lb. body weight per day. Those sulfonamides with the heterocyclic ring, pyrimidine, are most active against Gram-negatives as well as Gram-positives.

Paul Little, Lederle Laboratories Division, American Cyanamid Company.

Oxalated blood was used for horses, sheep, and cows. Due to the nature of pig and dog blood which clots more rapidly, the following expedient was used:

- 35 cc. of saponin solution was measured into 125 cc. Erlenmeyer flasks.
- 5 cc. of blood was measured directly into flask from syringe, and contents mixed.
Upon receiving flasks, 10 cc. of 15% trichloracetic acid was added with shaking, allowed to stand 10-15 minutes, and filtered. This represents a 1-10 dilution.

For cat and rabbit blood, in order not to take large amounts of blood so frequently from small animals—

1 cc. of blood from 5 animals each was added directly from the syringe to flask containing 35 cc. of saponin solution and protein precipitated with trichloracetic acid as above.

| TABLE III.—% incidence of important toxic reactions noted in man in the course of sulfonamide therapy |
|-------------------------------------------------|---|---|---|---|---|---|
| REACTION                                 | SULFA-  | SULFA- | SULFA- | SULFA- | SULFA- | SULFA- |
|                                          | METHA-  | DIAZINE| GUANIN-| THIAZOLE| PYRIDINE| ANIL-  |
| Fever                                    | 2.04    | 1.55   | 3.98   | 2.14   | 4.98   | 2.78   | 5.1    |
| Rash                                     | 2.04    | 1.49   | 3.58   | 2.82   | 4.26   | 2.11   | 2.62   |
| Leucopenia                                | 1.8     | 1.37   | 2.44   | —      | 1.3    | 2.28   | 1.92   |
| Cyanosis                                  | 0.26    | 1.45   | —      | —      | —      | 4.81   | 20.22  |
| Nausea and vomiting                       | 1.55    | 2.2    | 3.04   | —      | 10.5   | 40.2   | 5.67   |
| Hematuria—gross and microscopic           | 1.6     | 3.01   | 6.99   | 0.56   | 7.32   | 7.14   | —      |
| Vertigo                                   | —       | —      | —      | —      | —      | 27.67  | —      |
| Total                                     | 9.29    | 11.07  | 20.03  | 5.52   | 28.36  | 59.32  | 63.20  |

There are no adequate statistics available indicating sulfonamide toxicity in domestic animals. This chart was prepared to show the commonest symptoms associated with toxicity in man and involves over 5000 cases.

PROCEDURE USED FOR MILK SAMPLES WAS AS FOLLOWS

Make a 1-20 dilution, precipitating protein with trichloracetic acid as for blood. Mix. Let stand 1 hour before filtering. Filter. If filtrate is cloudy, refilter through same filter paper. We experienced no difficulty in obtaining clear filtrates by this procedure, and sulfonamide concentration was determined as in blood filtrates.

The survey comprised approximately 3,000 assays on 7 species of animals, using 7 sulfa compounds, and was carried out in the period from January 1946 to December 1946.

Sulfonamide toxicity is usually concerned with kidney failure, but includes blood changes as well. The pathologist looks for changes in the kidney, specifically tubule occlusion. Most toxic symptoms are traceable to mechanical tubular damage. The damage includes precipitation of the drug in the tubule resulting in compression of the epithelium with partial necrosis. Leucocytes surround the drug-crystal aggregates (Table I).
**FATE OF SULFONAMIDES IN ANIMALS**

**Table IV.—Comparison of the activity of Sulfadiazine and Sulfathiazole in a Pasteurella infection in mice**

Organism: *Pasteurella multocida*, strain 310, Lederle.
Infection: Intraperitoneal; 0.5 cc. of a $10^{-7}$ broth dilution of a 5-hour TSP-blood broth culture; 40 + 10 organisms.
Treatment: Drug-diet method; starting 3 days before and ending 6 days after infection.

<table>
<thead>
<tr>
<th>PER CENT DRUG IN DIET</th>
<th>DOSAGE</th>
<th>RESPONSE SURVIVAL ON 21ST DAY AFTER INFECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Drug intake</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mg./kg./day</td>
</tr>
<tr>
<td>Sulfadiazine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2/10</td>
<td>510</td>
<td>9.0</td>
</tr>
<tr>
<td>1/10</td>
<td>260</td>
<td>5.4</td>
</tr>
<tr>
<td>1/20</td>
<td>140</td>
<td>3.7</td>
</tr>
<tr>
<td>1/40</td>
<td>50</td>
<td>2.1</td>
</tr>
<tr>
<td>1/80</td>
<td>19</td>
<td>1.4</td>
</tr>
<tr>
<td>1/160</td>
<td>5</td>
<td>—</td>
</tr>
<tr>
<td>S.D. — 50; † 45 ± 10 mg./kg./day</td>
<td>S.B.C. — 50; ‡ 2.0 ± 0.2 mg.%</td>
<td></td>
</tr>
<tr>
<td>Sulfathiazole</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/10</td>
<td>2000</td>
<td>7.2</td>
</tr>
<tr>
<td>4/10</td>
<td>860</td>
<td>3.7</td>
</tr>
<tr>
<td>2/10</td>
<td>380</td>
<td>2.4</td>
</tr>
<tr>
<td>1/10</td>
<td>180</td>
<td>1.6</td>
</tr>
<tr>
<td>1/20</td>
<td>62</td>
<td>—</td>
</tr>
<tr>
<td>1/40</td>
<td>25</td>
<td>—</td>
</tr>
<tr>
<td>S.D. — 50, 250 + 50 mg./kg./day</td>
<td>S.B.C. — 50, 2.0 + 0.2 mg. %</td>
<td></td>
</tr>
<tr>
<td>Untreated controls</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Blood concentrations of drug in the infected animals were determined by the Bratton and Marshall method, as free drug on pooled tail blood samples on the third day after infection.
† Median survival dose.
‡ Median survival blood concentration.

This protocol illustrates the importance of blood concentration of sulfonamides. It should be noted that 5 mg. % is highly effective. The chart further indicates that, whereas approximately 1½ gr./lb./day of Sulfadiazine maintains a 5 mg. % level, it took more than 7 gr./lb./day of Sulfathiazole to maintain the same level.

Sulfamerazine and Sulfamethazine react similarly to Sulfadiazine.

Chemotherapy Division, Stamford Research Laboratories, American Cyanamid Company.
In veterinary medicine we are particularly interested in sulfonamides which have Gram-negative activity as well as exerting Gram-positive bacteriostasis. Table II, illustrates by structural formula the therapeutic activity of the thiazole, pyridine, and the pyrimidine rings, including the monomethyl and dimethyl pyrimidine derivatives against hemorrhagic septicemia in the mouse and chick.

**Sulfonamide Blood Levels in Swine**

![Graph showing blood levels of various sulfonamides in swine](image)

Fate of $\frac{1}{2}$ gr/lb. (71.5 mg/kg) in a single dose per os

Toxicity statistics for numerous sulfonamides in man involving more than 5000 reports are shown in Table III. Because most toxic reactions following the use of sulfonamides, other than loss of appetite, anuria, and depression are concerned with symptoms not easily recognized in animals, and require laboratory procedures not always available to the veterinarian to demonstrate leucopenia and microscopic hematuria, statistics on toxicity in animals following the administration of therapeutic doses are not generally available.

Those drugs with the pyrimidine ring, namely, Sulfamerazine, Sulfadiazine, and Sulfamethazine are reported to be least toxic.
Lack of toxicity of Sulfaguanidine is explained because of the very low blood levels obtained in usual therapeutic doses.

The protocol shown in Table IV illustrates the relationship of blood levels to activity. It is apparent that, for all practical purposes, Sulfathiazole is just as effective as Sulfadiazine when the same blood levels are maintained. However, it should be noted that the survival dose of 50% of the mice (S.D. 50) of Sulfadiazine is 45 ± 10 mg./kg./day as compared with S.D. 50 of Sulfathiazole which is 250 ± 50 mg./kg./day. It took 5 times as much Sulfathiazole to control infection even in a drug-diet method of administration. The survival-blood concentration of 50% of the mice (S.B.C. 50) was equal at 2.0 ± 0.2 mg. %.
Graphs 1 to 7 are concerned with comparisons of a single fixed dose of drug, $\frac{1}{2}$ gr./lb. (71.5 mg./kg.) per os. The levels shown represent the average of 4 or more mature normal animals. Jugular blood was used. The same animals were used for each drug after a rest period to permit correct drug comparisons. Individual animals may vary considerably from the levels shown but, for practical purposes, we may consider the comparisons true. This has been borne out in subsequent studies. Generally speaking, we are not concerned with the rapidity with which effective blood levels are established after oral administration, since effective levels can always be established immediately by parenteral administration of drug. We are concerned, however, with the persistence of levels beyond the twelve-hour period.

**Sulfonamide Blood Levels in Cats**

*Graph 6*
All columns represent free drug. The variations between free and total sulfonamide (degree of acetylation) were inconsequential.

All sulfonamides are constantly passing through the kidney. Some are rapidly excreted like Sulfathiazole. Others are reabsorbed from the tubules and are plasma-bound thereby maintaining high blood levels like Sulfamethazine. Tissue levels and the percent of tissues which take up sulfonamides is important as well. Bone and fat do not take up sulfonamides well. Adequate tissue levels are in turn dependent on adequate blood levels.

**Sulfonamide Blood Levels in Rabbits**

<table>
<thead>
<tr>
<th></th>
<th>Sulfamethazine</th>
<th>Sulfadiazine</th>
<th>Sulfathiazole</th>
<th>Sulfaguanidine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mg. %</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Hours 1</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Hours 4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Hours 8</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Hours 12</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Hours 24</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Fate of $\frac{1}{2}$ gr/lb (71.5 mg/kg) in a single dose per os

Graph 7

Inadequate levels and fluctuating blood levels are responsible for the development of drugfast strains of bacteria.

For purposes of economy in veterinary medicine, a drug should be selected which will maintain an adequate level for 24 hours if possible on once a day administration. It will be apparent from these graphs that sulfonamides react differently in each animal species. Each sulfonamide appears in the same position and is identified in the same manner in each graph.

Generally, Sulfamethazine holds the highest drug levels over the longest period. Sulfaguanidine has been added to show that, like Sulfathalidine and Sulfasuxidine, it should not be depended on for the control of systemic infections. These drugs may modify the bacterial flora and consistency of the stool in dysentery, but will not be effective in controlling the attendant septicemias with pneumonia.
In the dog, few of the drugs persist well after the 12-hour period on low dosage. Sulfamerazine and Sulfamethazine show good levels at 12 hours. It would seem, therefore, that, when possible, it might be wise to administer small doses at 12-hour intervals.

**Sulfanilamide Blood Levels in Animals**

![Graph showing blood levels of Sulfanilamide in various animals.](image)

The rabbit reacts differently from the other animals. Large and frequent doses are necessary to be effective.

The second group, graphs 8 through 14, show the blood levels attained in 7 animal species for each of 7 sulfonamides.

The great variation in response to the same dose of the same drug in different species becomes apparent. The dog and cat, the cow and sheep, the swine and horse follow more or less similar patterns.
FATE OF SULFONAMIDES IN ANIMALS

Sulfapyridine Blood Levels in Animals

Graph 9

Sulfathiazole Blood Levels in Animals

Graph 10
To effectively treat infectious bacterial disease we should:
1. Put the animal at rest.
2. Increase the caloric intake.
3. Increase the fluid intake.

Adequate dosage for animals includes:
1. Maintenance of levels above 5 mg. preferably above 8 mg., 24 hours a day. Excessively high levels, (above 20 mg. per 100 cc.) are both wasteful and dangerous, and should be avoided.
2. Selection of a drug which has the desired range of bacterial activity effective against Gram-negative as well as against Gram-positive organisms and coccidia.
### Table V.—Sulfonamide dosage. Treatment period—maximum 6 days

<table>
<thead>
<tr>
<th>DRUG</th>
<th>SPECIES</th>
<th>INITIAL DOSAGE</th>
<th>MAINTENANCE/ LB.</th>
<th>INTERVAL/HR</th>
<th>DAILY DOSE</th>
<th>TOTAL AVERAGE DAILY DOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>gr./lb.</td>
<td></td>
<td>gr./lb.</td>
<td></td>
<td>Lb.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>gr./lb.</td>
<td></td>
<td>Grams</td>
</tr>
<tr>
<td>SN</td>
<td>Horse</td>
<td>1</td>
<td>½</td>
<td>12</td>
<td>1½</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td>Cow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>65.0</td>
</tr>
<tr>
<td></td>
<td>Swine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.25</td>
</tr>
<tr>
<td></td>
<td>Dog</td>
<td>1</td>
<td>½</td>
<td>12</td>
<td>1½</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Cat</td>
<td></td>
<td></td>
<td></td>
<td>1½</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.2</td>
</tr>
<tr>
<td>SP</td>
<td>Swine</td>
<td>1½</td>
<td>1</td>
<td>24</td>
<td>1½</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.25</td>
</tr>
<tr>
<td></td>
<td>Horse</td>
<td>1</td>
<td>½</td>
<td>12</td>
<td>1½</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td>Cow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>65.0</td>
</tr>
<tr>
<td></td>
<td>Sheep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.25</td>
</tr>
<tr>
<td></td>
<td>Dog</td>
<td>1</td>
<td>½</td>
<td>12</td>
<td>1½</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Cat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.13</td>
</tr>
<tr>
<td>ST</td>
<td>Horse</td>
<td>1½</td>
<td>½</td>
<td>8</td>
<td>2½</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td>Cat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>Swine</td>
<td>1½</td>
<td>½</td>
<td>4-6</td>
<td>3-4</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>130.00-200.0</td>
</tr>
<tr>
<td></td>
<td>Cow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.5 - 10.0</td>
</tr>
<tr>
<td></td>
<td>Sheep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.3 - 2.0</td>
</tr>
<tr>
<td></td>
<td>Dog</td>
<td>1½</td>
<td>½</td>
<td>8</td>
<td>2½</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Rabbit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.26-0.4</td>
</tr>
<tr>
<td>SD</td>
<td>Horse</td>
<td>1½</td>
<td>½</td>
<td>12</td>
<td>1</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td>Cow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>65.0</td>
</tr>
<tr>
<td></td>
<td>Sheep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.25</td>
</tr>
<tr>
<td></td>
<td>Cat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>Swine</td>
<td>1½</td>
<td>½</td>
<td>12</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Dog</td>
<td>1½</td>
<td>½</td>
<td>8</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Rabbit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.13</td>
</tr>
<tr>
<td>SM</td>
<td>Horse</td>
<td>1½</td>
<td>½</td>
<td>12</td>
<td>1</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td>Cow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>65.0</td>
</tr>
<tr>
<td></td>
<td>Sheep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.25</td>
</tr>
<tr>
<td></td>
<td>Swine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.25</td>
</tr>
<tr>
<td></td>
<td>Dog</td>
<td>1½</td>
<td>½</td>
<td>12</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Cat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.13</td>
</tr>
</tbody>
</table>
### Table V—Concluded

<table>
<thead>
<tr>
<th>DRUG</th>
<th>SPECIES</th>
<th>INITIAL DOSE</th>
<th>MAINTENANCE/IN.</th>
<th>DAILY DOSE 1st day</th>
<th>SUBSEQUENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>gr./lb.</td>
<td></td>
<td>gr./lb.</td>
<td>gr./lb.</td>
</tr>
<tr>
<td>Smeth</td>
<td>Horse</td>
<td>1 ½</td>
<td>24</td>
<td>¼</td>
<td>¼</td>
</tr>
<tr>
<td></td>
<td>Cow</td>
<td>¼</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sheep</td>
<td>½</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swine</td>
<td>12</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cat</td>
<td>6</td>
<td>2 ½</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rabbit</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 grain = 0.065 grams.

SN = Sulfanilamide, SP = Sulfapyridine, ST = Sulfathiazole, SD = Sulfadiazine, SM = Sulfamerazine, Smeth = Sulfamethazine.

The dosage of sulfonamides should vary depending on the type and severity of infection and the condition of the host. The doses recommended here are average and flexible. Treatment for 1 day may be adequate and should never exceed 6 days. Both initial and subsequent doses may be given parenterally or orally or divided so that a portion is given parenterally to establish high initial blood levels.

3. Use of a drug which will maintain adequate levels for 24 hours following an initial nontoxic dose or at least one which will only require 2 times a day treatment.

The sulfonamides generally are poorly soluble, but their sodium salts are highly soluble.

These soluble salts in 25% w/v sterile solution, though quite alkaline, can be injected by any parenteral route to:
1. Establish immediately effective high blood and tissue levels.
2. Permit giving a sulfonamide when oral administration is impractical or when the animal is unable to retain the orally administered drug.

The nonsterile solution of the sodium salt likewise can be added to drinking water or milk. It is sufficiently palatable to permit maintenance of adequate levels when given in concentrations of from 1:500 to 1:1000.

The sulfonamides have been used in this manner in the group treatment of infectious disease in poultry, mice, rats, guinea pigs, hamsters, chinchillas, rabbits, and fur bearers.

Administration in water guarantees adequate water intake. The water intake goes up as the drug intake goes up.

The clinician must be concerned—
1. When there is abnormal or impaired renal function which disturbs the normal pattern of absorption and excretion.
2. When the treated animal fails to respond. You may be dealing with a sulfonamide-fast strain, and some other form of treatment should be tried.
3. When anuria exists and the animal is not taking water. Crystalluria (deposi-
tion of crystals in kidney tubules) may result. If water intake is adequate, one need not be concerned. Most animals, except carnivors, have alkaline urine which increases solubility of sulfonamides.

From these studies, it would seem that the schedule shown in Table V should be adequate for the animal with normal kidney clearance.

The dose per unit bodyweight administered, the completeness of absorption of the drug, the distribution of the drug in the body (active tissues—not fat or bone) kidney efficiency, and the excretion rate of the sulfonamide used, all influence sulfonamide therapy.

The field of chemotherapy is new. Great advances are close at hand. The veterinarian must select his cases for sulfonamide therapy with care.

An abstract in the Journal of the American Pharmaceutical Association for June, 1946, states:

"... No manufacturer has yet been able to offer anything which will serve as a substitute for clinical judgment ..." "Because of the rapid advances in drug therapy, the study of rational drug therapy must also be pursued actively ..."

BIBLIOGRAPHY


THE USE OF SULFAMETHAZINE IN THE CONTROL OF CERTAIN INFECTIOUS DISEASES OF LIVESTOCK

BY W. T. S. THORP, D.V.M., M.S., AND E. J. STRALEY, V.M.D.

Pennsylvania Agricultural Experiment Station

I am sure that the history of the early development of sulfonamides is so well known to you that it needs only brief mention here. Sulfanilamide, the first drug of this kind developed, was first made in commercial quantities about 1935, but it was so difficult to obtain and so expensive that it was not extensively used for animal treatment until some years later. Following the development of Sulfanilamide, several others have been developed that have broader application or use for specific purposes. The search is still being continued by chemists here and abroad to find better chemotherapeutic agents for the treatment of human and animal disease. These new compounds are continually being tested and evaluated and we have every reason to believe that more effective agents of this type will be available in the future.

Experimental studies and clinical trials have been reported on the use of sulfapyridine for calf pneumonia, sulfaguanidine, sulfasuxidine, and sulfathalidine for calf scours, and sulfamerazine, sulfathiazole, and sulfadiazine for pneumonia. Sulfamerazine and sulfaguanidine have been reported useful for coccidiosis in chickens primarily, but also, less extensively, in calves. Some of these drugs have become almost standard treatment for the diseases mentioned as well as for others.

The hospital and other facilities available to the physician for the evaluation of sulfonamides permits him to make a closer check than is usually possible for the veterinarian. We can not, however, accept the findings on human beings and directly apply the evaluation to animals as it has been shown that there is a marked variation in the response of different species to the same sulfonamide. In clinical trial work with a new sulfonamide or any other agent used in treatment, an adequate number of normal as well as sick animals must be used, the drug dosage must be given in relation to the age and weight of the individual, different means of administration used, and other obvious factors taken into consideration. In the evaluation of sulfonamides, it is important to know the blood concentrations of the drug, the time elapsed between dosage and the establishment of a maximum level, and the length of time the drug remains in the blood stream at a therapeutic level. It is important, also, to determine the effectiveness of the drug in reducing morbidity losses as well as mortality losses.

Within the last few years, sulfonamides known as the "pyrimidine" group have been developed and appear to be among the best available for the treatment of animal disease. The best known of this group are sulfadizine, sulfamerazine, and sulfamethazine. This report deals with experimental studies and observations on the clinical use of sulfamethazine. Hawkins (1), Horton-Smith (2) and (3), and

1 Presented by the senior author before the fiftieth annual meeting of the United States Livestock Sanitary Association, December 4, 5, 6, 1946, Chicago, Ill.
Swales (4) and (5) reported on its use for cecal coccidiosis. Through the courtesy of various practicing veterinarians and other investigators, unpublished data on the use of sulfamethazine has been made available to us. These data will be published in detail at a later time by the individual investigators, but it seemed desirable that a summary of these early reports be made available at this time.

We have reports on some twenty-five cases of foot rot that were treated by other veterinarians. Dosage was at the rate of approximately 1 grain per pound, and some were treated intravenously and others by mouth. Cases that were treated when lameness was first noted usually made an uneventful recovery when given treatment for one day. In older cases, however, when there was considerable swelling of the coronary band and adjacent parts, treatment once a day for three days brought about recovery in all but a few instances, but these showed improvement. These were retreated a week or ten days following the initial treatment and we have reports on only one case that failed to respond to one or more treatments. It would appear that, in the advanced cases having considerable swelling, the circulation of the involved part is impaired and it takes more time to establish a therapeutic sulfonamide level in the edematous areas than it does in early cases where the circulation is not as impaired. This treatment for foot rot seems to have promise as a simple, effective, and economical means of control considering the losses this condition causes in dairy and beef herds.

In one large institutional herd, mastitis was proving to be a costly and troublesome problem. For some time past, this herd had the highest average milk production of similar herds in the state. With the exception of the herd manager and his immediate assistants, the major portion of the work was done by patients with mental ailments and the conditions of sanitation as well as management practices could be considered no better than fair.

Physical and bacteriological examinations were made of the herd and it seemed desirable to treat all four quarters of 127 animals. The herd was divided into three groups—one received penicillin alone in varying amounts; the second, infusions of sulfamethazine alone; and the third received a combination of both. In most instances, the penicillin was used at the rate of 25,000 units per quarter repeated four successive times; others received treatment with the same amounts of penicillin together with 5 gm. of sodium sulfamethazine; and the third general group received 5 gm. sodium sulfamethazine administered as a 5 or 10% w/v solution.

Within the next month or two, and regardless of the type of treatment used, several animals developed acute mastitis. A detailed study of the herd history indicated that, at about the time treatment was started, an acute outbreak of mastitis was probably impending. Starting treatment at that time was unfortunate from a production point of view, as the volume of useable milk was reduced, but it did give an excellent opportunity to study the various types of mastitis. A total of 54 cows, having 101 quarters involved, were retreated. Thirty-four of these quarters were infused with 25,000 units of penicillin together with 5 to 10 gm. of sodium sulfamethazine in a 10 percent w/v solution. In most instances, this treatment was repeated four times in a two to three day period. Eight quarters were treated with 100 cc. of the 10% sodium sulfamethazine solution together with
100,000 units of penicillin per quarter on two successive days. Essentially the same treatment was used on 59 other quarters but, in addition, these animals were given sulfamethazine at the rate of 1 gr. per pound body weight by mouth once daily and the treatment continued for four days. Virtually all of these animals treated by these various means were returned to the milking line but, for various reasons, some few were disposed of for meat purposes.

The work on this herd gave indication that the intramammary injections of sulfamethazine and penicillin broadened the range of activity and that stubborn cases of mastitis might be benefited by such combined treatment. It was found also that, when sulfamethazine was administered orally at the rate of 1 gr. per pound, sulfonamide milk levels were obtained that were bactericidal or bacteriostatic. Following this finding, several cases of acute mastitis in this and in other herds have been treated with sulfamethazine using the drug at the rate of 1 gr. per pound. Animals showing acute mammary involvement and having temperatures from 104° to 107° have been given intravenous injections of sodium sulfamethazine. Their temperatures returned to approximately normal in six to twelve hours and the udders began to soften. Oral treatment at the same rate was continued for three days at which time the animals appeared normal and the milk was of a salable quality.

When sulfamethazine is given intravenously, a therapeutic blood level is obtained immediately. However, when the same amount of the drug is administered by mouth, approximately the same therapeutic blood level will be obtained in about six hours following treatment. Treatment of acute mastitis with sulfamethazine by oral or intravenous methods to establish effective blood levels has distinct advantages as the drug is carried by the vascular system to the affected parts, builds up a more effective drug level in the milk, and would seem to penetrate most of the udder. When materials are infused into congested udder tissues, they must be diffused through the structure. This appears to be a slower and less effective means of treatment of acute mastitis than when such a drug as sulfamethazine is carried to the infected parts by the blood stream. In subacute or chronic mastitis, udder infusions seem to give fairly satisfactory results but, in acute mastitis, and especially those cases accompanied by high temperatures, intravenous or oral treatment has given superior results.

We have reports also on a limited number of calves that were treated with sulfamethazine for enteritis or scours. Treatment was at the rate of \( \frac{1}{2} \) to 1 gr. per pound body weight given once daily, usually for three days, and occasionally for four. This was found to be highly effective. Calf pneumonia was treated at the same dosage levels. The majority made an uneventful recovery. There were a few cases, however, in which treatment was started after there was considerable lung involvement and these made slow recoveries or died. This, again, would appear to be due to impairment of the circulation of the affected lungs and the failure to establish a therapeutic sulfonamide level in the pneumonic areas. From previous work, it seems equally difficult to get penetration of such tissues with penicillin. Obviously, therefore, treatment should be started as early as possible for maximum results.

It may be worth mentioning that four calves having acute coccidiosis were treated
with sulfamethazine at the rate of 1 gr. per pound for three days. About twenty-four hours following the first dose, blood disappeared from the feces and the appetite and appearance of the animals was somewhat improved. A week later, three of the animals seemed to have made a complete recovery. The fourth, although somewhat improved, was retreated and made an uneventful recovery. More extensive trials, of course, should be made on this problem but this small trial seems encouraging.

At one of the major ports for shipping horses and other animals to European countries, shipping fever in horses proved to be a major problem. Usually 200 or more horses were being treated for shipping fever at one time and sulfanilamide and sulfathiazole were extensively used. The animals to be treated were run through chutes and were individually treated twice a day, but death losses continued at too high a level. Out of the infected group, seventy representative horses were selected for treatment with sulfamethazine. Several of these had failed to respond favorably to other sulfonamide treatment. The majority, however, were treated with sulfamethazine only, when sickness was first noted. In most instances, the drug was given at the rate of 1 gr. per pound body weight by mouth but many of the more acutely ill were given the initial dose intravenously. Usually, the drug was used for four days but occasionally it was continued through the fifth and sixth days. Of the seventy animals treated, one died and sixty-nine made uneventful recoveries. It was felt that sulfamethazine had particular advantages in the treatment of shipping fever in horses as one treatment per day maintained an effective therapeutic level and seemed to have a wider bactericidal range than the other sulfonamides used. Also, its use necessitated the movement of the animals through the chutes only once a day and reduced injury to them, gave them more time to rest, and cut in half the amount of work needed in their treatment and care.

Of 230 pigs diagnosed as having necrotic enteritis, 211 were treated with sulfamethazine. The majority of these animals had been scouring two to four weeks and, despite various treatments tried, 62 had died. The herd was divided into three groups of which 161 were given sulfamethazine in the feed at the rate of 1 gr. per pound body weight the first day and 1 gr. per pound body weight on the second and third days. Sodium sulfamethazine 25% w/v solution was injected intraperitoneally at the same rate into 50 that were more acutely ill than the others and 19 were left as controls. Blood samples were drawn from representatives of each of the two groups being treated, 24 and 48 hours after treatment, and those receiving intraperitoneal injections showed an average blood level of 9.3 mg. % and those receiving the drug in their feed averaged 6 mg. % of sulfamethazine. Clinical improvement in the treated groups was marked and, at the end of 24 hours, the animals were active and alert, food and water consumption was increased, and scouring had ceased. Within the first 48 hours of treatment, there was a 2.8% loss in the treated group and a 6.6% loss in the untreated controls. The herd was examined two weeks after the last treatment and the treated group appeared normal and healthy and were gaining in weight while the control group showed little if any improvement.

Pneumonia, due to Hemophilus suis, occurred in a herd of 200 twelve week old pigs of mixed breeding. These pigs were being fed garbage and 35 had died at the time treatment was started. These animals were divided into three groups, of which
150 were given sulfamethazine in the feed at the rate of 1½ gr. per pound body weight the first day and 1 gr. per pound body weight on the second and third days. Fifty of the animals more acutely ill were given intraperitoneal injections of sodium sulfamethazine 25% w/v solution at the same rate and 50 were left as controls. Within 24 hours, both treated groups were alert, the appetite improved, coughing had decreased, and no further death losses occurred. Among the controls, one to three died each day and 22 percent were lost within the first week. This group was then treated with sodium sulfamethazine and made an uneventful recovery. Coughing and clinical illness disappeared in the entire herd within a week of treatment, and all animals appeared healthy and were eating and gaining in weight.

METHODS AND PROCEDURE

To fully evaluate sulfamethazine, ten normal calves of approximately the same age and weight were given a series of dosages of sulfamethazine. One group of calves received 0.5 gr. per lb. of body weight of sodium sulfamethazine intravenously at one dose and 1.0 gr. per lb. per os for the first day. On the second, third, and fourth days, each calf received 0.75 gr. per lb. per os. Each in the second group received 0.75 gr. per lb. of sodium salt intravenously and 1.25 gr. per lb. per os on each of the subsequent three days. Each calf in the third group received 1.0 gr. per lb. intravenously, 2 gr. per lb. per os on the first day and 1.5 gr. per lb. per os on the second, third, and fourth days. One calf received 1.0 gr. per lb. per os at 9 a.m. as the initial and only dosage. In this case blood determinations were made more frequently for the first six hours after dosage. Another calf received 1.0 gr. per lb. of sodium sulfamethazine intravenously and 3.0 gr. per lb. per os the first day, and on the subsequent three days it received 3.0 gr. per lb. per os once a day. This was an attempt to produce toxic manifestation by extremely high dosage.

In all instances where intravenous injections were used in addition to the oral dosage, both were given simultaneously. With the exception of one calf, all dosages were given at 9:00 a.m. and blood samples were taken at two hour intervals. In addition to the ten normal calves used for dosage and toxicity studies, blood determinations were made on ten clinical cases which were treated for various conditions. The chemical determinations for sulfamethazine were made by standard methods commonly used for this purpose. Non-protein nitrogen determinations were made for three days before administration of the sulfamethazine and during the course of treatment.

Hematological studies were made consisting of hemoglobin, red blood cell counts, white blood cell counts, and differential counts. All of the normal calves used for this study were slaughtered at the end of the experiment, and sections were saved for histopathological study from kidneys, livers, and spleens.

FURTHER CLINICAL TRIALS

The use of sulfamethazine and sodium sulfamethazine for clinical cases in several large dairy herds and a large beef herd are the basis for part of this report. They consisted of two cases of pneumonia, two cases of complications following retained
CHART 1. Showing blood concentrations of free sulfamethazine for various dosages in normal calves.

Dosage administered: Calf no. 20—weight 85 pounds. 1 grain per pound i.v. and 2 grains per pound per os, 1st day; 2nd, 3rd, 4th days, 1¼ grains per pound per os.

Calf no. 21—weight 85 pounds. ½ grain per pound i.v. 1½ grain per pound per os, 1st day; 2nd, 3rd, 4th days, 1 grain per pound per os.

Calf no. 22—weight 65 pounds. ¼ grain per pound i.v. 1 grain per pound per os, 1st day; 2nd, 3rd, 4th days, ¼ grain per pound per os.

TABLE 1.—Showing some clinical uses of sulfamethazine and sodium sulfamethazine intravenously

<table>
<thead>
<tr>
<th>CASE NO.</th>
<th>ANIMAL</th>
<th>DIAGNOSIS</th>
<th>INITIAL DOSAGE FIRST DAY</th>
<th>SUBSEQUENT DOSAGE</th>
<th>TOTAL DAYS TREATED</th>
<th>BLOOD LEVEL IN 24 HOURS</th>
<th>RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bovine</td>
<td>Metritis</td>
<td>66</td>
<td>66</td>
<td>3</td>
<td>12.80</td>
<td>Good</td>
</tr>
<tr>
<td>2</td>
<td>Bovine</td>
<td>Naval infection</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>15.02</td>
<td>Good</td>
</tr>
<tr>
<td>3</td>
<td>Bovine</td>
<td>Retained placenta</td>
<td>70</td>
<td>70</td>
<td>4</td>
<td>17.25</td>
<td>Fair</td>
</tr>
<tr>
<td>4</td>
<td>Bovine</td>
<td>Retained placenta</td>
<td>70*</td>
<td>70</td>
<td>4</td>
<td>No sample</td>
<td>Good</td>
</tr>
<tr>
<td>5</td>
<td>Bovine</td>
<td>Mastitis</td>
<td>40† &amp; 80</td>
<td>100</td>
<td>3</td>
<td>16.28</td>
<td>Fair</td>
</tr>
<tr>
<td>6</td>
<td>Bovine</td>
<td>Mastitis</td>
<td>25† &amp; 54</td>
<td>41</td>
<td>4</td>
<td>10.56</td>
<td>Good</td>
</tr>
<tr>
<td>7</td>
<td>Bovine</td>
<td>Mastitis</td>
<td>70</td>
<td>70</td>
<td>3</td>
<td>No sample</td>
<td>Fair</td>
</tr>
<tr>
<td>8</td>
<td>Bovine</td>
<td>Mastitis</td>
<td>90</td>
<td>90</td>
<td>4</td>
<td>15.80</td>
<td>Good</td>
</tr>
<tr>
<td>9</td>
<td>Bovine</td>
<td>Foot infection</td>
<td>20</td>
<td>20</td>
<td>4</td>
<td>12.24</td>
<td>Good</td>
</tr>
<tr>
<td>10</td>
<td>Bovine</td>
<td>Pneumonia</td>
<td>6† &amp; 4.6</td>
<td>4.6</td>
<td>4</td>
<td>9.03</td>
<td>Died</td>
</tr>
<tr>
<td>11</td>
<td>Bovine</td>
<td>Pneumonia</td>
<td>4.2† &amp; 3.2</td>
<td>3.2</td>
<td>4</td>
<td>11.00</td>
<td>Good</td>
</tr>
<tr>
<td>12</td>
<td>Swine</td>
<td>Pneumonia</td>
<td>11</td>
<td>11</td>
<td>4</td>
<td>No sample</td>
<td>Good</td>
</tr>
</tbody>
</table>

* 40 gm. additional were placed in the uterus.
† Sodium sulfamethazine given intravenously in 5% or 10% solution.
placenta, one case of metritis with acetonemia, four cases of mastitis, one of navel infection, and one foot infection following injury. A summary of sulfamethazine treatments and results is shown in Table 1. Blood samples were taken from most of the cases.

One or two of these clinical trials should be mentioned in detail:

(1) A Hereford calf weighing 300 pounds received an injury to the right rear foot consisting of a puncture just above the coronary band on the medial claw. The wound was probed and swabbed, dressed with sulfathiazole powder, and bandaged. The next day there was considerably more swelling and an excess of granulation tissue. The calf's temperature was 104.8°. The excess granulation tissue was trimmed away and the foot was soaked for 15 minutes in hot magnesium sulphate solution, 20 grams of sulfamethazine being given per os (approximately 1 gr./lb./day). That afternoon the foot was soaked again and rebandaged. The temperature was 103.4°. The next morning the 20 gram dosage was repeated and the foot soaked again in magnesium sulfate. The temperature was 102.5°. This procedure was repeated for the next two days at the end of which time the temperature was within the normal range. The sulfamethazine was continued for one more day making a total of five doses after which a more permanent bandage was placed on the foot. Twelve days later the bandage was removed and good recovery had taken place. The blood concentrations of sulfamethazine for this calf are shown in Chart 2.

(2) A Hampshire boar, weighing 165 pounds, developed a respiratory impairment three days before examination and treatment. Upon examination, a diagnosis was made of acute pneumonia with a temperature of 105.4°. Treatment consisted of
11 grams of sulfamethazine per day for four days (approximately 1 gr./lb./day). The temperature was down to normal by the second day and the symptoms of respiratory impairment was greatly reduced. At the end of the four-day treatment, the pig had made a good recovery.

In an experiment using several hundred four-week old chickens, sulfamethazine was used in 0.2% and 0.4% concentrations in the mash. This was given for a period of 2 days, 72 hours after inoculation with infectious oocysts. This procedure successfully controlled the coccidiosis and prevented the development of fatal cecal coccidiosis. When used in concentrations of 0.4% it has reduced mortality when given after symptoms appear. The details of these experiments will appear in a separate report.

A small number of cows in the mid-portion of their lactation period were given 1.0 gr. per lb. of body weight of sulfamethazine, and the milk samples were examined every two hours to determine the concentration of sulfamethazine in the milk. Blood concentrations were determined every six hours. Although further tests are being made, the concentration of free sulfamethazine in the milk ranges from 30% to 50% of that in the blood. Should these figures be maintained after repeated trials, this sulfanamide may have definite possibilities in some cases of mastitis. It has been used on six cases which did not respond to penicillin with fair to good results. In these cases and in the experimental cows for milk studies, the blood concentrations obtained range from 12.6 to 16.8 mg. percent.

DISCUSSION

The actual use of sulfonamides in the treatment of animal disease meets with many variations. Thus, many items must be considered in the evaluation of the sulfonamides. In a review of the sulfonamides several years ago (6), it was noted that there are many and varied applications for these drugs.

Sulfonamides are better chemotherapeutic agents for acute than for chronic conditions. When therapeutic blood levels are established, temperatures of treated animals should drop in 12 to 16 hours in most cases. In general it can be said that sulfonamides should be given for three days, in some cases four, but rarely for five days, and then stopped. All sulfonamides probably produce some toxic reaction, therefore, prolonged administration is not recommended. There is little danger of toxicity or tissue injury when sulfonamides are properly used. If the sulfonamide used is effective, the animal being treated should show definite improvement within a 24 to 72 hour period. If improvement is not noted within that period, the animal should be re-examined and another type of treatment considered. In cases of relapse of the disease, the course of treatment should be repeated. Half doses of sulfonamides as after-treatment only invite the possible development of sulfonamide resistant organisms.

SUMMARY

Sulfamethazine has a wide range of bacteriostatic activity, being effective against both gram positive and gram negative organisms as well as coccidia.

This sulfonamide establishes and maintains effective blood levels in cattle on once a day administration.
The dosage consisting of \( \frac{1}{2} \) grain per pound body weight intravenously and one grain per pound body weight per os given the first day, and \( \frac{1}{2} \) grain per pound body weight per os, on the second, third and fourth days, is recommended. At this rate, blood levels in calves were maintained at 8 to 12 mg. percent.

Following oral dosage of 1 grain per pound of body weight the concentration of sulfamethazine in the milk of cows in mid-lactation was 30 to 50 percent of that in the blood.

Sulfamethazine proved non-toxic in calves given the therapeutic dose for 4 days. No toxic symptoms were observed. Hemoglobin, red and white blood cell counts and differential counts were normal. Histopathological studies on liver, spleen and kidney sections were negative in those animals given the therapeutic dose.

While no panacea, sulfamethazine has given promising results in the treatment of foot rot, mastitis, hemorrhagic septicemia, necrotic enteritis in hogs, pneumonias and metritis.

REFERENCES

REPORT OF THE COMMITTEE ON MISCELLANEOUS TRANSMISSIBLE DISEASES


It will be recalled that this committee reported in 1945 that
1. there is no formal accurate overall report on either morbidity or mortality statistics for domestic animals in the United States, and
2. there is an urgent need for standard nomenclature (nationally accepted list of causes of death for animals), and
3. there is immediate need for an accurate compilation of vital statistics.

It was pointed out that any report this committee presented on miscellaneous transmissible diseases would be of limited value because of this lack of authoritative statistics.

We recommended that:

1. This association give its full support to the establishment of diagnostic laboratories . . . , and
2. These laboratories be the staffing nuclei of vital statistics reporting . . . (statistical and diagnostic laboratories), and
3. A list of causes of death be compiled and published . . . , and
4. The disease name listed in an official manual be used by diagnostic (and statistical) laboratories . . . veterinarians and animal disease workers for . . . vital statistics . . . (for uniformity in reporting), and
5. A Division of Vital Statistics be established directly as part of the Department of Agriculture . . . and
6. These statistics be made readily available and distributed annually . . . , and
7. There be established a Committee on Vital Statistics (which might replace this committee).

Again it should be stressed that the subject as a whole is not new and that those who pioneered in this field, although inactive at present, are giving their moral support. It has become apparent that the goal of this committee has been independently pursued by many other organizations, both domestic and foreign, and that the concerted effort of these groups is culminating in the adoption of a solid workable program.

The immediate active cooperating groups in this country include the committees on (1) Nomenclature and (2) Vital Statistics of the A.V.M.A., (3) The Committee on Veterinary Services for Farm Animals of the Agricultural Board, Division of Biology and Agriculture, National Research Council, National Academy of Sciences, (4) The U. S. Bureau of Animal Industry, (5) the U. S. Bureau of Agricultural Economics, (6) the Agricultural Research Administration, (7) the Association of Land Grant Colleges, (8) the directors of experiment stations, (9) National
Assembly of Chief Livestock Sanitary Officials, and (10) National Livestock Loss Prevention Board. The support of commercial organizations, including biological and pharmaceutical manufacturers, meat packers' and national producers associations, is being sought. It would seem that greatest progress can be made by coordinating our activities and participating in the program of the National Research Council and that our association should formally back their program by adopting the following resolutions.

Whereas, there is an urgent and immediate need for a formal report on morbidity and vital statistics of domestic animals, and

Whereas, the Committee on Veterinary Services for Farm Animals, of the Agricultural Board, National Research Council, National Academy of Sciences, as a preliminary move to make a methods study has proceeded with a livestock loss survey at Ames, Iowa, under the immediate direction of Professors G. W. Snedecor, A. J. King and Dr. D. P. Dodd. The survey is jointly sponsored by the Iowa Experiment Station, the U.S.B.A.I. and the U.S.B.A.E., and

Whereas, data obtained according to the procedures of the “Master Sample of Agriculture” for the fiscal year April, 1946 to April, 1947, will be compiled and reported by Dr. Dodd through the N.R.C. as an introductory procedure, and

Whereas, following this report the design and techniques for the total program can be decided upon, and

Whereas, the U.S.B.A.I. has an existing functioning organization within each state, which, supported with additional funds, might conveniently take up accurate disease assembling, and

Whereas, the U.S.B.A.I., through the Division of Meat Inspection, can aid in correlating disease findings at the slaughterhouse with the source of the livestock, and

Whereas, with additional funds, suitable laboratory facilities might readily be installed or added to existing units, for the purpose of making accurate diagnoses part of the meat inspection service, and

Whereas, the practicing veterinarian should be required by law to report all deaths in his area within his knowledge to a central source, citing the cause with as great accuracy as possible, securing laboratory aid when confirmation of infectious disease is desired, and

Whereas, many organizations have an immediate interest in this program, each should be informed of progress being made by the Committee on Veterinary Services for Live Stock of the N.R.C., and

Whereas, the success of the program and control of livestock is dependent on early and accurate reporting, and

Whereas, the economics of morbidity have even greater importance than mortality, and

Whereas, suitable laboratories (statistical and diagnostic) will have to be established throughout the country, and

Whereas, the supply of competent laboratory animal disease diagnosticians is inadequate to satisfy the program and the U. S. Senate and House of Representatives are both cognizant of the need for scientific research and the education of talented young scientists, and
Whereas, since heavy losses of animals occur on farms where veterinary service is not available, stockmen fail to report such losses, and
Whereas, proper interpretation of statistics cannot be accomplished unless a universally acceptable nomenclature of causes of death of animals is used in the report, and
Whereas, it is necessary to abide by standard methods in diagnosis, and
Whereas, Public Law 733 (HR-6932) "To provide for further research into basic laws and principles relating to agriculture and to improve and facilitate the marketing and distribution of agricultural products", has been amended to provide funds which might be used by the U.S.B.A.I. and U.S.B.A.E. to proceed with this program, be it
Resolved, that this committee henceforth be identified as "The Committee on Morbidity and Vital Statistics" (which will include miscellaneous infectious diseases), and be it further
Resolved, that this association give its approval and full support to the program concerned with surveys on livestock losses and economics of morbidity established by the Committee on Veterinary Services for Farm Animals, of the National Research Council, and be it further
Resolved, that the following cooperating organizations, committees, associations and bureaus be informed of progress made by the Committee on Veterinary Services for Farm Animals concerning morbidity and vital statistics, National Assembly of Chief Livestock Sanitary officials, National Livestock Loss Prevention Board, the Committees on Nomenclature and on Vital Statistics, A.V.M.A., Committee on Miscellaneous Transmissible Diseases, U. S. Livestock Sanitary Association, U.S.B.A.I., U.S.B.A.E., U.S. Agricultural Research Administration, Association of Land Grant Colleges; and experiment station directors, and be it further
Resolved, that this committee work directly with the Department of Agriculture and its various bureaus concerned with this program, and be it further
Resolved, that this association go on record as favoring the establishment of a division within the U. S. Department of Agriculture for the accumulation of Morbidity and Vital Statistics, to be in direct contact with the state livestock sanitary official, the U.S.B.A.I. field inspector, the county veterinarian, the public health veterinarian, the practicing veterinarian, extension veterinarian, and farm advisor, and be it further
Resolved, that this association suggests that the U. S. Department of Agriculture print and distribute a manual of causes of death, using the draft now being compiled by the Committee on Nomenclature of the A.V.M.A., and further that revisions be made every ten years or oftener, and be it further
Resolved, that this association go on record as favoring the establishment of laboratories (statistical and diagnostic) in as great number and as rapidly as funds and available personnel will permit, utilizing existing offices, laboratories and personnel where possible, and be it further
Resolved, that we favor a modified curriculum for graduate and undergraduate study in veterinary medicine to specifically prepare the student to participate in laboratory diagnostic procedures, including statistics, and that the need for this type of service be publicized, and be it further
Resolved, that facilities be provided for a teaching center where pathological tissue specimens, bacterial cultures, viruses, protozoa and parasites may be studied, and be it further

Resolved, that this association favors the inauguration of an educational program designed to acquaint veterinarians and livestockmen with the value of this program, and be it further

Resolved, that the U. S. Department of Agriculture be encouraged to annually distribute a Statistical Report eventually to include (1) causes of all deaths in animals, species and breeds, by sex and age groups, (2) morbidity, with causes and incidence in all animal species and age groups including the economic picture, (3) reports to include (a) National, (b) State, (c) Territory, and (d) Sectional divisions. Tables are to be supplemented by graphs and maps, and be it further

Resolved, that this report in its entirety be forwarded to the Secretary of Agriculture and copies to the Chief of the Agricultural Research Administration, the Chief of the Bureau of Animal Industry, the Chief of the Bureau of Economics, the U. S. Public Health Service, the President of each land grant college, the Director of each experiment station, the Chairmen of the Committees on Nomenclature and on Vital Statistics of the A.V.M.A., the Chairman of the Committee on Veterinary Service for Farm Animals of the N.R.C., the President of the National Assembly of Chief Livestock Sanitary Officials, the President of the Livestock Loss Prevention Board, and the Chairmen of the Agricultural Committees of both the U. S. Senate and the House of Representatives, biological and pharmaceutical houses, packers and producers associations.

It is believed that such a program will directly benefit this organization, livestockmen, agriculture as a whole, the veterinarian, the public health worker, the packer, the manufacturer of products for the treatment of animal disease and the consumer of animal products. It will (1) increase production, (2) reduce the unit cost, (3) be beneficial to the general health of the nation by aiding in the control of disease transmissible from animal to man.

There appears to be no opposition; enthusiasm is general for the immediate adoption of the program. The time for the over-all survey to get underway is now; the program is unbiased and for the public good.

Mr. President, I move that this report be submitted to the executive committee for approval so that action may be taken on the resolutions presented by this committee.
LIVESTOCK DISEASE PREVENTION AND CONTROL IN CANADA

BY ORLAN HALL, V.S., D.V.M.

Chief Veterinary Inspector, Animal Contagious Diseases, Health of Animals Division, Department of Agriculture, Ottawa, Canada

When your Secretary honoured the Health of Animals Division, Production Service, Canadian Department of Agriculture, by requesting that a member of the Division appear on this program, I presume he had in mind the Veterinary Director General, who is in a much better position to deal with the subject matter of this paper than I. It is regretted, therefore, that Dr. Barker is unable to attend this meeting.

It is gratifying to me, however, to have the opportunity of addressing you at this the Fiftieth Annual Meeting of the United States Live Stock Sanitary Association.

If I understand the constitution and bylaws of this Association correctly, the purpose of this organization shall be the study of live stock sanitary science, milk and meat hygiene and the dissemination of information relating thereto, the unification so far as possible of the laws, regulations, policies and methods pertaining to milk and meat hygiene and the prevention, control and eradication of transmissible live stock diseases including those of poultry; to maintain co-ordination among the various livestock regulatory organizations and to serve as a livestock sanitary science clearing house between this Association and the livestock owner, the livestock sanitarian, the milk and meat hygienist, the veterinary practitioner, the transportation and stock yard companies, the milk and meat producing and distributing companies and various other interested agencies.

A half a century is a considerable length of time in the life of any organization with these objectives in view and the progress which you have made from year to year has been carefully followed.

Sanitary officials not only of this country but of other lands including Canada look forward to your Annual Meetings, when the outline of sanitary measures are given full consideration together with the dissemination of information on live stock diseases of economic importance to the well being of all.

We in Canada have looked with pride upon your accomplishments. We can recall the eradication many years ago of pleuro pneumonia contagiosa from the cattle herds of your country. I believe on seven different occasions foot and mouth disease invaded this country and on seven different occasions the disease was completely eradicated. An accomplishment of major importance to the livestock and allied industries of this country. Your accomplishments in the control of bovine tuberculosis are recognized as one of the greatest of organized veterinary medicine of any country in the world and I venture to say that the benefits derived therefrom by stock owners of this country have already far exceeded the cost by many millions of dollars.

One should not, however, overlook the fact that north of the International
Boundary there lies a country, divided into nine provinces comprising 3,695,189 square miles, known as Canada with a boundary line extending from the Atlantic to the Pacific Oceans of over 3,000 miles on which are located quarantine ports and inspection ports of both countries.

In Canada we have according to the last available figures horses—2,396,850, cattle—10,385,000, hogs—5,377,300, sheep—3,378,400 and poultry—66,604,200. This will give you some idea of the area of the country and the number of live stock which we are required to protect.

Our National Veterinary organization is in many respects similar to the National organization in this country. There is, however, a difference.

The Animal Contagious Diseases Act is administered by the Health of Animals Division, Production Service, Canadian Department of Agriculture, which is entirely a federal organization. The same can be said for the Meat and Canned Foods Act.

Not only does the Animal Contagious Diseases Act contain the necessary authority to prevent or control the importation of live stock into the country, but it also contains authority for the prevention and control of the products of animals and of the soil likely to convey the infection of foreign animal diseases. Authority exists for the control of veterinary biologics. It also contains authority for the control and eradication of infectious or contagious diseases such as glanders, farcy, maladie du coit, pleuro-pneumonia contagiosa, foot and mouth disease, rinderpest, anthrax, Texas fever, hog cholera, swine plague, mange, scab, rabies, tuberculosis, Brucellosis, actinomycosis, etc., variola ovina and others.

Regulations and Orders are rigidly enforced and Canada's reputation for having one of the healthiest live stock industries in the world is no chance happening.

Her favourable geographical location with water on the east and the west, ice bound on the north nearly the year around and with the United States on the south from which we are quite confident serious foreign animal plagues will never secure a beach head has placed us in a rather enviable position.

Much credit, however, goes to those public spirited and far seeing veterinarians of earlier days who laid the foundation and wisely administered regulations and orders for the purpose of preventing the introduction into our country of foreign animal plagues. This together with those who followed kept the country abreast and sometimes ahead of public opinion in the prevention and control of contagious diseases of livestock.

Rinderpest, contagious pleuro-pneumonia or foot and mouth disease the more serious of the foreign animal plagues have never invaded our country, although on two occasions in our history foot and mouth disease was dangerously close.

On one occasion many years ago the disease was detected in a shipment of cattle from Great Britain which was undergoing quarantine at our Animal Quarantine Station at Levis, Quebec, necessitating the slaughter of all animals on the Quarantine Station premises. These were foreign animals and according to the Animal Contagious Diseases Act "Foreign Animals" mean animals not already introduced into Canadian territory, outside of Quarantine Stations.

On one other occasion, when the disease had invaded your country, veterinarians of our Federal Department of Agriculture observed from the North Shore of the
Niagara River officers of your country destroy a herd of cattle infected with foot and mouth disease on the South Shore of Niagara River near Buffalo, N. Y. Thanks to the thoroughness with which the disease was eradicated by United States officials and the rigid restrictions imposed by Canada, the disease did not invade our country.

We do have diseases of economic importance with which we have to deal. Anthrax is not prevalent in Canada and, while one cow on a farm in Eastern Ontario was found affected during the fiscal year 1944–45, there were no cases reported during the fiscal year 1945–46.

No case of dourine (maladie du coit) has occurred in Canada since 1919 indicating the disease has been eradicated.

We have not had a case of glanders in Canada since 1937.

We do have the odd case of mange in horses, for example in the fiscal year ending March 31, 1946, one horse was found affected in the province of New Brunswick and three in the Province of Quebec and no mange in cattle was reported for that year.

Sheep scab has not occurred in Canada since 1927 indicating the disease has been eradicated.

The disease known as scrapie appeared in a flock of sheep in the province of Ontario during the fiscal year ending March 31, 1946. It was the first appearance of the disease in Canada. Appropriate regulations were established by Order in Council and the flock comprising one hundred and two head of sheep was ordered slaughtered and $2,131.00 compensation paid to the owner. No further cases have been confirmed.

In October 1942 rabies appeared in the county of Essex, Ontario, which county is directly south of Detroit, Michigan, in the United States. Due to the spread of the disease it became necessary to quarantine the city of Windsor and a considerable portion of the county of Essex. The Order provided that all dogs within the area be effectively confined or securely tied up. The disease spread to two other counties which adjoin. The outbreaks in these counties were controlled by individual quarantine and through the co-operation of municipal and township councils passing bylaws controlling dogs running at large within their jurisdiction. Control the dog and you control rabies is the method which we have followed. Canada remains free from rabies with the exception of the three counties in Ontario above indicated and there has not been a positive case confirmed in these three counties since March 1946.

Ministerial Order No. 62 restricting the entry into Canada of dogs from the United States of America and Ministerial Order No. 60 restricting the entry into Canada of dogs from the continents of Europe, Asia and Africa on account of rabies have been rigidly enforced.

One may ask why these Orders and why not adopt vaccination? Canada does not choose to live with rabies if this can be avoided. We believe that, if we can prevent the introduction of the disease into our country and control the infection within which we have had since 1942, we can maintain the country free of the disease.

Hog cholera occurred on six premises in Nova Scotia and four in Ontario for the year ending March 31, 1946, involving the slaughter of 228 hogs for which the owners
received in compensation $1,857.00. Under our policy of slaughtering all swine on infected premises, no difficulty was experienced in eradicating the disease. Here again one may ask why not adopt the serum-virus method? The answer is why live with the disease when we can control it within practical limits by following a slaughter policy. We do make use of serum alone to a limited extent when controlling an outbreak.

I cannot recall a single case of hog cholera being introduced into Canada through the live animal. During the past thirty years most of our outbreaks have been traced to the feeding of garbage, consequently any person who feeds to swine or permits swine to have access to or to be fed on his own premises or on the premises of any other person, corporation or municipality, any garbage, raw or cooked, composed of any of the following: meat scraps, offal, kitchen waste, fruit or vegetable refuse, or other matter edible by swine and which has been obtained elsewhere than on the premises where fed, or from any hotel or restaurant, shall, unless special permission in writing is first obtained from the Veterinary Director General, be guilty of an offence under the Animal Contagious Diseases Act.

Special permission in writing is in the form of a licence and to obtain such licence the owner must place his premises in an acceptable sanitary condition and install suitable cooking facilities. The premises are visited periodically in order to determine if the owner is complying with the Department's requirements by satisfactorily cooking garbage and maintaining his pens and premises in a clean condition. If not, his licence is cancelled after appropriate warning.

Human nature being what it is we cannot expect perfection from all who feed garbage and, while we do have the occasional outbreak resulting from carelessness in cooking and when small quantities of raw garbage are fed on unlicensed premises without our knowledge, yet our policy has resulted in keeping our swine practically free from the ravage of the disease. At the present time there are 665 premises where garbage is fed under license on which are maintained 62,535 hogs.

In so far as is known at the present time Newcastle disease of poultry does not exist in Canada.

Authentic cases of Brucellosis of swine has not to my knowledge been reported but the same cannot be said for cattle. This disease is present in all provinces of the Dominion and, while our individual herd blood test policy may not be considered by some as an aggressive policy, the fact remains that there are 2,715 herds under the supervision of the Health of Animals Division and of this number 1,838 are listed as free from the disease.

Calfhood vaccination with Strain 19 is not officially carried out by the Health of Animals Division. Some Provincial Departments of Agriculture do sponsor a fairly aggressive calfhood vaccination policy. Any veterinary practitioner who is registered to practice in the province in which he resides may obtain a permit for the purchase of vaccine Strain 19 and administer it to calves between the ages of four and eight months if the stock owner desires to employ him.

Progress in the control of bovine tuberculosis in Canada is not all that can be desired. Our efforts during the war years have been retarded and there still remains a shortage of veterinary inspectors for duty within the Service, especially the field section. Notwithstanding, however, we are endeavouring to meet commitments as far as possible.
Of an estimated 10,385,000 cattle in the Dominion 4,197,389 are dealt with under
the restricted area plan and of this number 2,424,652 are in accredited areas, that
is in counties or districts where the number of reacting animals has been reduced
to one-half of one per cent or less. In addition there are 300,000 cattle in accredited
herds and 350,000 in supervised herds (grade herd policy).

Approximately half of the cattle in Canada are under Federal supervision for the
control of tuberculosis and as near as can be estimated tuberculosis will not exceed
two per cent in those remaining to be tested.

We are an exporting country and a considerable number of our live stock find
their way into your country.

Permit me to quote from the Live Stock Market Review of the Canadian Depart-
ment of Agriculture for the week ending November 7, 1946: "Dairy cattle ship-
ments to the United States totalled 1,106 head for the week as compared with 482

<table>
<thead>
<tr>
<th>TABLE 1.—Restricted area plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROVINCE</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Prince Edward Island</td>
</tr>
<tr>
<td>Nova Scotia</td>
</tr>
<tr>
<td>New Brunswick</td>
</tr>
<tr>
<td>Quebec</td>
</tr>
<tr>
<td>Ontario</td>
</tr>
<tr>
<td>Manitoba</td>
</tr>
<tr>
<td>Saskatchewan</td>
</tr>
<tr>
<td>Alberta</td>
</tr>
<tr>
<td>British Columbia</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Cattle in Accredited Herds........................................ 300,000  
Cattle in Supervised Herds....................................... 350,000

Grand total.................................................... 4,847,389

in the same week last year. Exports since January 1st this year total 60,865 and
in the same period last year were 40,351 head."

The certification of these cattle which enter your country is the responsibility
of the Health of Animals Division, Production Service, Canadian Department of
Agriculture, and I have presented this brief review in order that Federal and State
officials may more clearly understand our position in connection with livestock
disease prevention and control in Canada.

We would have you believe that when you receive a certificate signed or endorsed
by a veterinary inspector of the Health of Animals Division that the health of the
animal is as reported and that the tests and examination have been carried out
as indicated on the certificate and the identity of the animal carefully checked and
recorded.

During the past two years it has been brought to our attention by those in charge
of the Federal Bureau of Animal Industry and by some State officials that on oc-
casions it has been found that some of our cattle have reacted to tuberculin tests at
different intervals after arriving in this country, cattle which allegedly had origi-
inated in Canadian accredited areas and accredited herds.

This was most difficult to understand and a close check was undertaken to detect,
if possible, the cause.

It was not until January 1946 that we arrived at the conclusion that there was the
possibility of substitution, that is the animal which was certified for export was not
in some instances the animal that was shipped, the ear tag identification
being switched by interested individuals.

The Service of the Royal Canadian Mounted Police were requested and an in-
tensive investigation undertaken which has not up to this time been concluded.
To date two Canadian cattle dealers and three from this country have been prose-
cuted with fines ranging from $50. and costs to $1,000.00 and costs. Charges have
been laid against others.

It is the determination of the Department which I represent to prevent at all
costs the substitution of cattle certified for export.

From information gained through police investigation it is believed that on
occasions the substitution has taken place after the properly certified animal is
admitted into this country, the tag being removed from the ear of the cow imported
from Canada and placed in the ear of a cow which had never been imported from
Canada.

May I suggest, therefore, that, before condemning any animal said to have origi-
nated in Canada, you closely check the ear tag identification to make quite certain
that someone has not switched the tag.

Your co-operation in this regard would serve a useful purpose in defeating those
few persons, who unfortunately appear to believe that honesty is not the better
policy, in connection with the live stock trade between two countries just so long as
their own financial interests are being satisfied.
BRUCELLOSIS IN OREGON

By Sam B. Foster, D.V.M.

Inspector in Charge U. S.—B.A.I., Portland, Oregon

Among Oregon's rich lore of pioneering, we feel honored in presenting for inclusion the investigations and field trials incident to the diagnosis and control of animal Brucellosis. In mentioning or commending the efforts of the early workers in such endeavors, it would be no less negligent than ungrateful to omit the name of our Chief of Bureau, Dr. Simms, who during his incumbency as director of our Oregon State College Laboratory, conducted experiments in testing, vaccination, segregation and other practices in quest of knowledge on this subject. Upon these initial informative successes and failures, combined with the pioneering gropings of other workers, we have gradually built up a substantial operating structure which now enables us to proceed along lines of control and eradication with more seasoned judgement and confidence.

In presenting any comments representative of Oregon's conditions, it need not and should not be assumed that the speaker recognizes any fundamental differences in the operative principles of a Brucellosis campaign whether it be in Oregon, Florida, Maine or Texas, but we must rivet the fact in our minds at the outset that the alternative of living with the disease is an infamous admission of surrender. The point of importance is that the principles of the sanitary battle be clearly recognized and then effectively integrated with the local conditions to the best advantage, altho a unified course of action on fundamentals should be effective throughout the nation and public pronouncements of progress reports and educational features should find release thru a national, central educational committee.

Many veterinarians and cattle owners are wrongly oriented on the first and most important principle involved in a cattle Brucellosis campaign. Whenever commercial considerations preponderate to the exclusion or the obscuring of human interests in this subject, then the veterinary profession falls far short of its commitment. The veterinarian who fails to establish a close working contact with his local or state health agencies, is not only curtailing the possibility of service, but is inherently selfish in denying his helpful contribution to the alleviation of human suffering.

In order to effect a liaison between the field veterinarian and health agency or individual doctor in the exchange of data, we have prepared a questionnaire which is completed on the farm at the time reactors are disclosed by the test. The function of the questionnaire is to reveal or at least to indicate the presence of Brucellosis in the family and to serve as a warning to the consumer of the infected milk, and as an invitation to seek medical advice. The respective questions elicit a few indicative symptoms and serve well as a preliminary intimation of danger.

There is more value in selecting controversial features of the project than in spending time in agreeing with each other on phases of mutual accord. There is some disagreement in my state on whether the campaign should be conducted by
BRUCELLOSIS IN OREGON

UNDULANT FEVER QUESTIONNAIRE

1. Name........................................................................................................................................
2. Address ........................................................................................................................................
3. Phone No...........................................

4. Has any member of your family lately shown signs of:
   a. Fatigue...........................................
   b. Intermittent fever (by thermometer.....)
      (by symptoms .....
   c. Joint stiffness..............................
   d. Muscular pains. ............
   e. Exhaustion...................
   f. Perspiration (mild........... by day. ...)
      (severe........... by night......)
   g. Frequent colds.........chronic cough (dry.............)
      (productive..............)
   h. Weight loss during recent years............
   i. Severe illnesses during recent years........
      Diagnosis?...................................
   j. Other?...........................................
      Chief ailment: ...................

5. How many in your family
   a. adults............
   b. children ...........

6. Is milk a part of your diet?....... cow’s....... goat’s....... 
   a. Do you consume raw milk?....... Pasteurized Milk?....... 
   b. Do all or any members of your family drink milk?....... 
   c. From what source do you get your milk? a. store...................
      b. milk truck delivery....... 
      c. family cow.............
   d. Do you use pasteurized cream?....... raw cream?....... 
   e. From what dairy or distributor do you purchase milk?........
      cream?....... ...........

f. Have you been getting milk from same source for a period of:
   less than six months....... 
   over six months ....... 
   many years ...........

g. Have you been away from home and consumed milk during such absence?
   yes....... No....... 
   when .......................................................... 
   where ..........................................................
   for how long? ....................................................
   raw....... pasteurized....... 

7. Do you use cheese?....... 
   Consumed principally as pasteurized product?....... Brand..................
   unpasteurized product?....... Brand ..................
   in cooked dishes? .................................

8. Do you use ice cream?....... From whom purchased?....... Brand...........

9. Does any member of your family work around or contact: a. Cows ............
    b. Hogs.............
    c. Goats............

10. Does any member of your family engage in butchering or handling of raw meat?

a. Where?

b. Occasionally?

c. Continuously?

Summary:

Diagnosis:

Source:

Investigator:

practicing veterinarians or by full time employees. To arrive at a conclusion, we should first determine what degree of appreciation we place on the importance of the project. Most will share with me that the Brucellosis control program is in the very top bracket of veterinary undertakings in that it has assumed a definite recognition as a public health program in addition to the great commercial phase of livestock improvement. We seem to think it proper to have full time dog catchers and full time rodent poisoners, but we put ourselves in the ludicrous position-of trying to cope with this most important sanitary project with part time men on a fee basis, working in conjunction with private practice at periods of permitted convenience. On summing up this phase of Tuberculosis and Brucellosis testing work, my steadfast opinion is that the project should be conducted by full time, well paid veterinarians of the city, county, state, government—or all of these agencies combined, which plan would assure continuous, uninterrupted schedules and abolish the inherent practice of giving priority of attention to the more conveniently located or larger, more profitable herds. We will here make mention of a common conclusion that when a herd is tested and reactors tagged and branded, the work of the veterinarian is only half completed, however on the per head testing fee basis, the testing contract on a fee basis is fulfilled without the necessary follow up. How about the personal supervision of the disinfection of the premises and structural corrections? The full time veterinarian is free from monetary time limitation and can effectively keep the second half of the tester’s obligation.

Every state is plagued with the lack of uniformity in state livestock admission laws and regulations. Some require 60-day tests and some 30-day tests and are annoying in other varying technicalities, but a surprising weakness in most of them is the utter disregard for herd history in evaluating the eligibility of an individual for entry into the state and in turn for addition to clean herds. What value has a certificate of negative test on a cow picked up at an auction ring and probably originating in a heavily infected herd? This cow legally crosses the state line just as completely vised as an animal originating in a one-hundred per cent clear herd, or one that has been vaccinated and found to be a nonreactor after the prescribed interval following vaccination. This is just one example of the need for national unification of interstate and state regulations covering the admission of livestock.

In any program, the subject of vaccination crops up and it has the faculty of
appearing as a dragon's head in one place and as a palliative love feast in another. We are often irritated with the wailings of chronic objectors who dwell on its flaws and frailties and can see no good in its application whatever, centering on a few isolated failures, but more effective than this for clouding our optimism, is the supervisor who thinks that there should be promiscuous vaccination or the one who thinks there should be no vaccination whatever but exclusively a test and slaughter program. We aim to build our vaccination program reflective of the local conditions as we find them, and as they successively develop. The state law is flexible in that it allows the owner one of three options—test and slaughter with indemnity; test, slaughter and vaccinate, in which owner slaughters all reactors and institutes an all calf vaccination program; or vaccination and retention of reactors with no indemnity if the percentage of reaction is ten per cent or greater, however the retention option will expire in November, 1947.

The range herds are operated on a strictly calfhood vaccination program as we feel that the one yearly test would be useless in view of the unknown but probable exposures during 11 months of the year. The calfhood vaccination on this class of cattle can be maintained on perfect schedule as all calves are of the same approximate age and can be vaccinated at the same time. We have one strictly dairy county which has never had a vaccinated animal within its bounds and for many years this county has not revealed a reactor on its annual tests notwithstanding a badly infected county borders it on one side. This fact is presented to show how antitheses in degrees of infection do and can exist side by side.

In spite of what might have been better methods or management, we in Oregon feel gratified at the substantial progress in battling down the incidence of Brucellosis into an uninterrupted recession. The figures here are not representatively statewide, as if two certain small areas of infection were deleted from the compilation, the percentages covering the remaining territory would appear much more favorable. In retrospect, for a period of ten years, we have reduced the percentage of reactors from 6.48 to 2.98. Ten years ago we had 69.55% of our herds negative, whereas at the present we have 88.86% of our herds negative. The percent of suspects ten years ago was 2.86, whereas at the present time it is 1.93. In spite of the critical ballyhoo that we were going to decimate the cattle population, it is interesting to note that the average number of cows per herd ten years ago was 10.83, whereas at the present time it is 11.74.

Altho statistics are informative, they are not the only indices of progress, as there is something even more encouraging which can be seen only by a person in constant personal contact with the livestock owners involved. This index is the trend of sincere effort that comes with proper appraisement of the accruing benefits. Today, even though we were inclined to be negligent in our sanitary technique, the great majority of owners will not now tolerate such hazards as use of single needle for entire herd blood aspirations, nor the clearing of lumen of needles by blowing with the mouth, nor tolerating the entrance upon premises without disinfected foot coverings, nor dirty suits on the inspectors, or uncleaned nose tongs or open mouth bleeding tubes.

All these sanitary vigilances on the part of owners are tangible signs of progress. One of the indicated checks on the field veterinarian's care in handling tubes and
bleeding operations is the statistical record of haemolysis in the laboratory. If the record shows an excess of one tenth of one percent of haemolization, the field supervisor is immediately out on investigation and in most instances is able to promptly effect remedial measures. Undue delays in dispatching tubes to laboratory, excessive agitation, exposure to sunlight, heat and cold, contamination with concentrated antiseptic are the major factors involved. For the completed year of 1945 our average was one-tenth of one per cent, the lowest with one exception for ten years.

One of the greatest responsibilities of a directing official is the preparatory training of his men. All too often an enthusiastic new graduate plunges into the routine of a Brucellosis campaign armed with only the superficial qualifications of aspirating blood into a tube. It is a set practice in Oregon that he undergo a course of practical meat inspection, then a month's instructional field course with a competent inspector. The hitch-hiking propensity of the Brucella abortus is so notorious that even the experienced inspector is taxed in identifying the avenues of transmission, which predicament shows how desultory and even harmful the services of a novice can be, as bleeding the animal is a very minor part of a Brucellosis control program. Oblivious to this, there are official agencies which fail to properly appraise the many ramifications involved, and unwittingly expose the whole livestock industry to the hazards of incompetence by placing so great a health program in the hands of lay inspectors. After all, diagnosis is only an informative adjunct and we must not entertain too much satisfaction in effecting mere control or even the cure of Brucellosis, but rather reserve our congratulations until a time when we have perfected a method of attaining the real utopian goal—PREVENTION!
BRUCELLOSIS AND ITS RELATION TO THE PRODUCTION OF LIVESTOCK

BY W. L. BAIRD

Waukesha, Wisconsin

I feel very highly honored to be placed on this program. Knowing and realizing the importance of the veterinarian, I am reminded at this time of what Will Rogers had to say in regard to the veterinarian. He said "This is a day of specializing. Say, for instance, there is something the matter with your right eye. You go to a doctor and he tells you, 'I am sorry, but I am a left-eye doctor; I make a specialty of the left eyes'. A doctor that doctors on the upper part of your throat doesn't even know where the lower part goes. And the highest priced one of all of them is one that just tells you which doctor to go to. The old-fashioned doctor didn't pick out a big toe or left ear to make a life's living on. No matter what end of you was wrong, he had to try to cure you single-handed. I have always felt that the best doctor in the world is the Veterinarian. He can't ask his patients what is the matter—he's got to just know." With this in view as to the prestige of the veterinary profession, I am still puzzled as to my selection. All I hope to do is to try to outline the situation we are in today relative to brucellosis, in the hope that this august body may outline better plans of control and eradication which will be accepted by the rank and file of breeders.

It just happens that I am a joint owner of a purebred herd of cattle which at present is certified as Bang's Free. This was accomplished by passing through trials and tribulations. The fact is we had a herd of purebreds with which we were having difficulty in getting 2-year-old heifers up to freshening age without having them abort, and many of our cows became shy-breeders and non-breeders with a tremendous loss of milk production as well as off-spring. The advent of the blood test was our salvation. By use of the blood test at various intervals we were able to rid the herd of the animals and infection that was causing the loss. With that experience I believe we can clearly state that the disease, Brucellosis, has a tremendous costly effect on the production of livestock, and has exacted a toll of millions from the breeders. On this disease control authorities are agreed.

Many controversial subjects will spring up among a group of breeders relative to the control of Brucellosis, but there is one subject on which they are all agreed, and that is the costly effect it has on the production of livestock. It is not only costly in the loss of blood lines and the progeny from purebred livestock, but also in the loss of calves in grade herds. This loss is reflected to the public and the trade as well as to the breeder, and whether grade or purebred herds, the loss in production is marked. The very nature of the disease signifies loss to the owner, and one of the penalties, not the least, is having to live with a loathsome disease.

I may state at the beginning that as the joint owner of a herd, a breeder, and also a dealer in livestock, which results in personal contact, not alone with all parts of our own state, but also with dealers and breeders from other states and foreign
countries, naturally, all factors bearing on production of livestock enter our discussions. As a result, it is difficult for me to evaluate the various opinions expressed, or to measure the amount of agreement that obtains in any group. I am speaking of the thoughtful men who express themselves earnestly and sincerely and who are interested from the standpoint of love of livestock, financial interest and also those who desire knowledge as to the most effective way of controlling a disease that threatens an industry in which they are interested.

One thing we do find and agree upon is that no one wants Brucellosis and I feel that the veterinary authorities in the various states should be complimented for the work they started.

During the progress of Tuberculosis Eradication, many times breeders attending association meetings pondered as to when the State and Federal Departments would render aid in the control of Bang's Disease or Contagious Abortion, names designated for the disease at that time; but particularly so following the successful culmination of the tuberculosis eradication campaign, in which the entire United States became a Modified Accredited Area. This achievement was looked upon by the entire breeding world as a signal success in disease control.

A survey covering Bang's disease at the time indicated that the cost of such a campaign would be enormous as I am informed fully 15% of the cattle population were estimated to have Brucellosis. However, the time arrived when the country began talking in millions instead of thousands of dollars for practically every purpose, and as you know, funds were made available for the elimination of diseased cattle from the herds of the United States. What more natural conclusions could we arrive at, considering the success that attended the Tuberculosis Eradication Program, than that a Federal-State Program would be evolved? This was done. The plan and mechanics which attended the Tuberculosis Eradication plan were largely incorporated into the campaign for the control of Brucellosis. It is interesting to review the avidity with which this program was taken up by the states that had completed their program of tuberculosis eradication, and it is also interesting to note the states that had not completed their program or had not started a program, utilized the funds for the eradication of tuberculosis, and to compare their programs with the other states today.

It may clearly be stated that the breed organizations welcomed this program with high hope, trusting it would be as successful as the Tuberculosis Eradication Campaign. As you are aware, our campaign was predicated on the basis of test, slaughter, sanitation, and indemnity payments. The progress following the inception was satisfactory to all concerned, including the breeder as the economic factors—of low prices on cattle and dairy products prevailed, and also the universal desire on the part of the breeder to eliminate a loathsome disease.

As time passed it was noted that Bang's or Brucellosis was more difficult to control than tuberculosis, no doubt due to factors peculiar to that disease, the recurrence of infection, mode of spread, reactors following clean tests, and general incidence of infection on contiguous farms. This all caused additional work, and with the advent of the war and the cry for "all-out" production, any cow became valuable in the eyes of the dairyman, with cattle and milk prices reaching unprecedented values. Naturally this deterred many breeders from taking up the program and
caused others to drop it. Test and slaughter lost its popularity. The owner would rather waive his indemnity than interfere with his production at the prevailing prices.

The hope of the breeder was for an easier way, and vaccination became a topic of discussion among our breed organizations. We knew that the United States Livestock Sanitary Association mandated the United States Bureau of Animal Industry to carry on a 5 year experimental program on calfhood vaccination. The breeders were anxious for progress reports, but hopeful that vaccination would solve their problem. Visitors from breed organizations from time to time visited Washington and came away with the spirit of optimism. In our state this caused a demand for the incorporation of a vaccination program, but the State and Federal Departments did not accede until a progress report was rendered by the United States Bureau of Animal Industry at a meeting of the United States Livestock Sanitary Association in December 1940 on Calfhood Vaccination. Immediately following this meeting, our state incorporated calfhood vaccination in its program. It seems the demand suddenly ceased following its incorporation. I do not think it afforded the relief that many expected as they were lead to expect too much. I firmly believe that it has its value as a measure in the control of the disease. We are finding today that many of our buyers, whether right or wrong, are asking for officially Bang's vaccinated animals. The demand is way beyond the source of supply.

We find in our purchases that there are animals whose titers do not recede following the 18 months time fixed. However, I do feel that such animals are not in sufficient number to be regarded as a loss as the increased prices on those that are successfully vaccinated and have lost their titer will more than compensate.

Immediately following the incorporation of calfhood vaccination in the program, there was a demand for adult vaccination. If rumor can be credited, and I know of many instances in which it can, the practice in certain sections was adopted regardless of regulations. I find in our search for cattle for shipment that we cannot purchase from those herds due to the fact that they go down on the blood test, and we have not been able to buy out of such herds for a number of years. It is my feeling that Bang's negative animals of the dairy breed is one of the largest sources of income in many of the states so represented here today. And it is my belief that for many years this may be a great source of income for the farmers of those states if the veterinary authorities and the breeders will keep their eyes on the ball,—which is more and better livestock negative to Bang's Disease through vaccination, or at least negative, unless state regulations are changed much from what they are today.

I feel that the industry would be better off if promiscuous adult vaccination were not practiced, but adult vaccination should be permitted in any herd wherein it is indicated predicated on a permit issued as a result of a questionnaire submitted by the owner and the veterinarian he employs. This insures the owner information as to what retarding factors might follow the result of vaccination in his herd. In other words, that he be fully informed on these matters. This system is employed at present on the official work in Wisconsin. I feel that with this knowledge he could easier make a determination if he wished to forego sales until vaccinated calves could be sold or make replacements in his own herd, and he could still have
the production from his herd in calves and dairy products (if profitable) to assist him in eliminating the disease.

I think we should give full consideration to the economic factors wherein they do not interfere with our control of the disease. If the laws of a commonwealth permit the maintenance of reactors, if would appear that possibly they could be elastic enough to permit under state supervision the interchange between herds of reactors and suspects for production as we now do for the perpetuation of blood lines and purebred progeny. Also we might include in this group reactor vaccinates due to retained titers.

One other factor which is the bane of breeders supplying cattle for out of state shipment is the lack of uniformity in state regulations to the extent that many breeders throw up their hands in horror at trying to keep a herd to comply to any regulations. This I maintain is not to the best interest of the livestock industry or the best interest of the farmer whose business it is to produce livestock to be used for production or foundation animals in other states. I also contend that it is not to the best interest of the veterinarians who have these regulations in charge.

My own personal feeling is that we should not chuck the blood test out the window as some have suggested, but have its more general use with intelligent interpretation; that the only way to get anywhere is in more general use of the test; and this is based on the experience and value of the test in our own herd; and in the herds of a thousand or more breeders with whom I come in contact.

Of late years in our breed organizations we have given space in our periodicals to writers who are critical of the Federal-State programs as administered in several states. This no doubt was based on a democratic premise. However, a review of these articles seem to lead to an all-out program of vaccination. This no doubt would be ideal if common agreement among authenticated research workers justified its adoption. I wonder if we have been as critical in the selection of the authors of these several articles as we should have been. It seems that over a period of years our journals have been filled with such articles, and if not accepted by the rank and file of breeders, it is possible it has left its influence, or at least left the breeder confused. These articles as well as one that is current surely must raise doubt in the minds of the readers as to the value of the blood test and the control measures sponsored by and approved by the committee of the United States Livestock Sanitary Association and the American Veterinary Medical Association. Current discussions still raise the questions relative to an animal reacting as a result of natural infection being a spreader or of danger to the susceptible animals in the herd at the time of parturition. Also another burning question: Is a vaccinate carrying a retained titer 18 months or two years after vaccination dangerous to the susceptible animals in a herd in which it is maintained? It would appear that some journal or periodical might do a valuable service, or at least dissipate confusion by an article based on a review and publication of the basic principles on which the value of the test was predicated and sponsored by scientific bodies and accepted by regulatory livestock agents as an index to infection.

A survey of the attendance roster of the United States Livestock Sanitary Association meetings indicates that the breeders are not in attendance. They were there in the years when tuberculosis eradication held the stage. Why this change?
We breed organizations may well ask that question; and I say this in all sincerity as I feel that there is a larger gap today between veterinary authorities and farmers and breeders than there was 25 years ago; and I also ask you veterinary bodies to ponder this question. With an economic hazard confronting us like Brucellosis, have we not a common cause? I believe that you are the people we should look to. Some years ago we had a concept, and I believe most of our breeders of today still hold that good veterinary service and good animal husbandry are interdependent.

A review of the curriculum offered by our veterinary colleges in the present day should justify our faith in our veterinary service being able to assist us in solving our disease control problems and also in our research institutions. I hope we can feel there is a common interest.

We as breeders are glad to know that Meat Inspection has been returned to the Bureau of Animal Industry where it properly belongs. At the present prices of livestock and dairy products, we know that breeders will always be keenly interested in a disease control program, and permit me to say in conclusion that according to my concept they will continue to be, even on the basis of changing prices and lowered economic scale, as it is fundamental that health is the greatest factor in a herd maintained for production and breeding.

Permit me to enumerate a few of the points on which the livestock industry and the veterinary profession needs greater enlightenment and coordination:

(1) The proper age for calfhood vaccination.

(2) The $64.00 question—is there a sound reason for elimination of Bang's vaccinated animals that do not completely lose their titer. It is granted that Bang's vaccination produces a reaction to the disease showing the antibodies developed to fight the disease. Then why penalize evidence of resistance? I am told that in some states today, animals that have been Bang's vaccinated at any age, regardless of titer they show, are sold at public sale, and that in some states today they sell for as much as if they showed no reaction. This change has come within two years. In Wisconsin they could not be sold except for slaughter if they showed a titer. However, in cases of proven production or to obtain valuable progeny, permit may be obtained to maintain them in another infected herd.

(3) A greater education of the rank and file of farmers and breeders to the value of “official vaccinates” over promiscuous vaccination; and blood testing.

(4) A greater and better understanding and cooperation between the livestock breeders and the health authorities.

In talking with a Secretary of one of the larger breed organizations within the past two weeks, I tried to find out what his attitude on the control of brucellosis was. He informed me that he hoped to see the day when vaccination would be in general use, and that no attention would be paid to the titer animals showed. I mention this just to show the feelings of some of the men that are in a position to guide the practices of purebred breeders.

(5) Greater uniformity in state regulations.

(6) More intelligent blood testing of more herds of cattle to determine their status as to health and then a program adopted in the herd to meet the situation. In my opinion there are a great many herds of dairy cattle in which no testing for Bang's is done for two reasons: afraid that a blood test will reveal something
that will be detrimental to the herd; and that if any reactors or suspects show, they will receive an official quarantine notice, and these may be on cattle that he has had no trouble with as they may be self-vaccinated animals that give him no trouble but do show a titer, while his neighbor who does no testing at all is allowed to maintain his herd without any interference of State or Federal authority. This, I believe, is the reason that many breeders are reluctant to accept the blood test.

(7) Consider means and ways of promoting official calfhood vaccination by areas.

(8) Realize that Brucellosis is a different disease than tuberculosis, which experience has shown us to date, and that the chances are it will have to be handled in a different manner.

I offer this for your consideration as the livestock breeders do depend on the veterinarian who has to know what is wrong with the patient.

I thank you.
BOVINE BRUCELLOSIS RESEARCH


Animal Disease Station of the Pathological Division, Bureau of Animal Industry, Beltsville, Maryland; United States Department of Agriculture, Agricultural Research Administration

The problems concerned with the development of effective methods for the control of bovine brucellosis have been many and widely varied in their nature. Although our present knowledge of the disease is quite extensive we should not lose sight of the fact that much of the ground work for current research dates back to the pioneering efforts of such early investigators as Bang, McFayden and Stockman, and others. Many of their experiments were already in progress at the start of the century. From this beginning a wide range of facts regarding the nature of so-called "infectious abortion" was provided during the next twenty-five years by the accumulated researches from many countries, including the United States, Denmark and England. The scope of these accomplishments can best be appreciated by summarizing briefly, the more important knowledge that has been available for at least two decades.

It has been established that the infected uterus, at the time of abortion or at an apparently normal calving, was the most important source for the spread of infection, although the uterus tended to free itself of Brucella abortus within a very short time after parturition. Young calves were known to be resistant to the disease and rarely if ever became permanently infected. Similarly, while bulls occasionally became infected in the genital tract, they were only infrequently responsible for transmission of the infection. Predilection of the organism for udder tissue and its frequent localization and consequent dissemination through the milk were accepted facts.

That these early workers on bovine brucellosis were interested in artificial immunization is evidenced by their published reports covering vaccination experiments in which living as well as killed cultures of Brucella abortus were employed as vaccinal agents. Their results were sufficiently encouraging to give promise for the intensive studies carried out along these lines by later investigators. The results of original vaccination studies indicated that the inoculation of cattle with living, virulent Brucella abortus organisms could produce sufficient resistance to significantly reduce the abortion rate and the extent of infection in artificially exposed animals. Unfortunately, however, it was later shown that such vaccines were capable of establishing chronic localized udder infections. Even though they would prevent many abortions, strong exception was subsequently taken to the use of living vaccines when the relationship between infected milk and undulant fever was determined. Thus, it is apparent that artificial immunization of cattle against brucellosis is by no means a new idea, but is one which has developed gradually over a period of almost half a century. Interest in vaccination has varied, of course, during the intervening years, and even though criticism has
been extremely severe at times, the obvious possibilities it presented encouraged research workers to continue their investigations.

With the development of serological methods of diagnosis, emphasis was directed toward eradication of the disease by the elimination of animals that reacted to the agglutination test. Other achievements included the development of laboratory procedures suitable for the isolation, identification and differentiation of Brucella species.

From this review, it would appear that these early investigators had done an excellent job in supplying at least the basic tools needed to undertake the formulation of control measures. However, as is too often the case with the practical application of principles, new problems arose which required a solution before anticipated results could be achieved. These problems began to multiply rapidly after the Federal-State cooperative program, based on the test-and-slaughter plan of controlling bovine brucellosis was inaugurated in 1934. Although a great deal has been accomplished by the elimination of infected animals, it became apparent that complete eradication along these lines alone, would be a difficult undertaking. Moreover, it was soon learned that total elimination of the disease from heavily infected herds by testing and removal of reactors is frequently a discouraging prospect which, if eventually successful, is accomplished only at great financial sacrifice. In many instances this sacrifice includes the loss of blood lines, which are difficult or impossible to replace.

The test-and-slaughter program has also been complicated by the fact that results obtained under what would be considered ideal conditions have not always given the results expected. Much too frequently it has been found that in one instance, what appear to be very thorough methods of testing and sanitation may have no value in controlling the disease, while in another, procedures less efficiently employed may bring prompt success. Thus, it seems likely that the results obtained by the elimination of reactor animals will depend largely upon the stage of infection existing in a given herd at the time control is undertaken. In those cases where the disease has been introduced recently and is accompanied by frequent abortions, there is obviously less chance of prompt success than is possible with a herd that has passed through these violent early stages of infection. The most favorable time to commence eradication would be after clinical manifestations have subsided. This, of course, is impossible and adds to the problems confronting complete eradication by the elimination of reacting cattle. Early discrepancies in the blood agglutination test results themselves, due largely to differences in methods of applying and interpreting the test, were later minimized by standardization of antigens and technique.

**IMMUNOLOGICAL STUDIES**

Factors such as these were responsible for the gradually increasing interest of research workers and stockmen alike, in supplementing the test-and-slaughter eradication plan with some other procedure. Thus, the majority of brucellosis studies, carried on both here and abroad, were concerned primarily with developing an agent which could be used to induce a serviceable degree of immunity in cattle. In this country, early evidence of effective vaccinal resistance was provided by
the investigations of Buck and Creech, in 1917, through which they were able to demonstrate a definite resistance in cattle to brucellosis after vaccination with suspensions of viable *Brucella abortus* organisms. This resistance appeared to be greatly reduced and transitory in character when the product was killed prior to injection. From this beginning, the work carried out by the Bureau eventually led to the development of strain 19 vaccine. As many of you know, this strain was first selected by Cotton and Buck for intensive study, at the conclusion of a series of vaccination experiments dealing with a comparison of *Brucella abortus* strains having varying degrees of virulence. Their results indicated that a strain so reduced in virulence that it seldom produced visible spleen lesions in guinea pigs would confer a distinct resistance in cattle.

At the time these experiments were in progress, strain 19 had been cultivated in the laboratory for a period of six years, and appeared to be quite stable, from the standpoint of reduced virulence. This fact was immediately recognized as a valuable asset and it has proved to be a very important factor in maintaining a uniform product for subsequent use. The favorable results of further investigations, carried out at the Animal Disease Station, were confirmed by other workers throughout the country. The additional work necessary for these confirmations has been of material assistance in building up the volume of experimental data required to justify conclusions.

Early in the course of the Bureau's work with strain 19 it was observed that vaccination of mature animals induced the formation of blood agglutinins, which could not be differentiated from those associated with virulent infection, and that these reactions tended to persist for considerable periods. It was readily foreseen, therefore, that such reactions would conflict with and tend to confuse any efforts to control the disease by eliminating reactors to the agglutination test. This led to a series of studies on the relationship of age to the resistance values established by vaccination, and the persistence of vaccinal agglutinins. It was from these experiments that vaccination of calves between the ages of 4 and 8 months was found to produce a serviceable degree of immunity, without the disadvantage of persistent blood agglutination titers. Instead of reactions continuing over a period of many months, as was frequently observed in adult vaccination, recession was sufficiently rapid that approximately 90 percent of the calves vaccinated in this age range would become negative within a period of 3 to 12 months. As regards resistance values, additional studies have indicated that the effectiveness of strain 19 vaccination increases with advancing age during the first year of life. In the light of these findings, therefore, it is reasonable to believe that the lower limits of vaccination ages could be increased to at least 6 months with advantage.

Several modifying factors have been encountered in making definite comparisons of results obtained in different vaccination experiments. One of these is the individual variation that cattle show in their immunological response, and another has been the difficulty of maintaining a standard value for exposures used to essay the vaccinal resistance. Both of these elements have, no doubt, influenced to some extent the final results of many experiments and probably account for some of the different opinions expressed on the subject of vaccination. We know that there are few if any bacterial diseases in which the resistance induced by artificial
methods is solid enough to withstand mass exposure. Bovine brucellosis is no exception in this regard. It is essential, therefore, in vaccination experiments where artificial exposures are used, to hold the test exposures within a range that will not submerge the resistance, but will still be adequate to demonstrate its relative level. It is quite probable that, as a whole, most experimental exposures used in the past have been on the severe side.

STABILITY OF VACCINAL STRAIN 19

Whenever a product incorporating viable elements is proposed as an immunological agent, there is a natural tendency to discount its worth until it is proved to be free of any danger of establishing disease. This has been true in the case of strain 19 and was the basis for some rather severe criticisms of its use. Although general observations, over a period of several years had indicated a remarkable constancy of virulence in strain 19, no results from investigations designed specifically to answer this question were available until later experiments along those lines were completed. These studies were carried out as deliberate attempts to increase the virulence of strain 19 by subjecting it to every condition known that might favor such a reversion. Included in the variety of procedures employed, was a series of passages through susceptible animals. This method is generally considered to be the most effective way of enhancing bacterial virulence and finds support in its successful application in several other bacterial species. The experiment was conducted in pregnant, first calf heifers, and because of the characteristic affinity of \textit{Brucella abortus} for uterine and fetal tissues, cultures used for successive passages were in all cases confined to recoveries from these sites. In order to be sure of producing abortions it was found necessary to use mass intravenous exposures of approximately $90 \times 10^8$ strain 19 organisms, which is considerably more than the $50 \times 10^8$ dose recommended for subcutaneous administration in routine vaccination. \textit{Brucella} recoveries made from the original abortion were used in a like manner to expose each succeeding animal. These serial passages were continued through a total of 6 animals. Throughout the experiment, 9 pregnant control animals were subjected to contact exposure by close confinement with the aborting principals; every effort being made to have susceptible control heifers available for addition to the experiment at intervals corresponding with artificial exposures.

Although typical \textit{Brucella} abortions accompanied by \textit{Brucella} recoveries from uterine and fetal tissues, occurred in all of the principals within 30 to 60 days following exposure, udder infection was demonstrated in only 3 of the 6 heavily exposed heifers at the time of abortion. The 9 controls, on the other hand, all calved normally at the termination of their first pregnancies, at which time each was free from any evidence of active infection. Additional examinations, extending over two more pregnancies, were conducted on the principals and controls alike without any further \textit{Brucella} recoveries being made. These findings were especially significant in the case of the principals which, in spite of the known heavy infection existing during their first pregnancies, subsequently calved normally without evidence of uterine or udder infection. This is in direct contrast to the
BOVINE BRUCELLOSIS RESEARCH

frequency with which persistent udder localization is associated with virulent Brucella infection.

Final recoveries made from the last aborting principal were indistinguishable from the originating stock strain, as determined by a critical comparison of morphological, cultural, antigenic and virulent qualities. The uniformity of virulence maintained throughout these studies is substantial evidence that strain 19 vaccine will not assume dangerous pathogenic properties under the conditions in which it is employed in the field. The results also show that recently vaccinated animals are not a menace to susceptible cattle, even when exaggerated conditions of contact exposure exist. This latter point is also supported by extensive data collected from the many vaccination experiments carried out at the Animal Disease Station during the past several years. These experiments are usually handled in such a manner that vaccinated and control animals are maintained as a single unit from the time the vaccine is administered until test exposures are applied. Even though some of these close associations have extended over periods as long as three or four years, there has never been any indication that vaccinated calves can spread infection to animals that were later shown to be non-resistant.

PERSISTENCE OF VACCINAL PROTECTION

The duration of resistance to brucellosis induced by a single vaccination of calves with strain 19 has long been an important question having a direct bearing on control procedures employed in the field. Although field results indicated that resistance values remained serviceable, under most conditions, through the fourth or fifth gestations, the data supporting these assumptions were far from adequate. Unfortunately, controlled investigations of this nature are necessarily long term experiments which cannot be completed as quickly as would be desired. Therefore, even though the necessary data are gradually being assembled, they are not yet extensive enough to justify conclusions. Moreover, there is considerable evidence that several factors, the influence of which cannot be anticipated in individual field herds, may have a pronounced modifying action on the duration and serviceability of vaccinal resistance. Included in these are (1) virulence of exposure, (2) degree of exposure and, (3) the response of the individual animal to the original vaccinal stimulation. In all probability, any one of these factors will appreciably alter the final protective values exhibited by vaccinated animals. With this in mind, it is a little difficult to see how any hard and fast rule defining the limits of vaccinal resistance can ever be formulated that will satisfy the unknown variables existing in different herds. If strain 19 vaccination gave absolute, rather than relative protection, the answer to this question would be infinitely easier.

ADULT VACCINATION

Although it is well known that adult vaccination is being increasingly employed in many sections of the country, discussions for and against the practice have not subsided. In the past, the two main objections to vaccination of mature cattle have been,—(1) the persistence of vaccinal blood agglutination titers, and (2) the danger of establishing permanent infection in pregnant or sexually mature animals. In considering the first of these points, we find general agreement that
blood agglutinins, stimulated by vaccination, do persist considerably longer in adult animals than in calves, and that such titers cannot be conclusively differentiated from those associated with virulent infection. Such being the case, there is an obvious conflict between blood testing and adult vaccination that cannot be ignored. As regards the danger of establishing permanent infection, there is still disagreement, although this is diminishing as further observations from the field, as well as controlled experiments have regularly failed to substantiate these fears. Investigations along these lines must be continued, of course, until all problems involved have been fully examined. Certain phases of these studies, now in progress at the Animal Disease Station, are being conducted in a self-contained field herd where the presence of rapidly spreading, virulent infection was observed just prior to the time the present vaccination program was inaugurated. Of the 163 adults vaccinated in this unit, 115 were injected by the usual subcutaneous method and the remaining 48 received intracutaneous injections of 0.2 cc in the caudal fold. While the data at the present time are incomplete, certain aspects are worth consideration. A brief summarization of results covering the immediate 12-month post-vaccination period shows an aggregate of 110 calfings, 84.5 percent of which were normal and free of any cultural evidence of brucellosis. The other 15.5 percent include 6 full-term parturitions, 3 of which were associated with highly virulent and 3 with low virulent Brucella recoveries, and 11 abortions. On the basis of cultural findings, 8 of these abortions, which occurred in animals pregnant at the time of vaccination, were due to Brucella infection and 3 to non-specific causes. Of the 8 Brucella abortions, 6 were definitely the result of virulent infection. The Brucella recoveries made in the other 2 cases were apparently the vaccinal strain 19. Even though both of these latter abortions are ascribed directly to the vaccination itself, it is apparent that such cases are extremely rare even under conditions where all stages of pregnancy are concerned. As regards the virulent Brucella recoveries, it should be pointed out that every animal in the herd was vaccinated irrespective of pre-vaccinal blood-serum agglutination status. An undetermined number of these animals, therefore, were infected before vaccination. In fact, a single pre-vaccinal milk examination conducted on the herd revealed the presence of at least two such animals. From the standpoint of methods employed for administering the vaccine, the number of abortions observed in each group is too low to justify conclusions as to preference. In the subcutaneously vaccinated unit, there have been 5 Brucella abortions out of 81 pregnancy terminations, or an abortion rate of 6.1 percent. This compares with 3 Brucella abortions out of 29 calfings, or 10.3 percent for the cattle vaccinated intracutaneously.

In general, results now available indicate that whole herd vaccination can be practiced, under emergency conditions where recently introduced infection requires prompt action, with very little danger of inducing abortions. Temporary reduction in milk production does occur, however, following vaccination of lactating cows. This loss is apparent in the first milking after injection of the vaccine and continues over a period of 7 to 10 days, before production returns to normal. The rapidity with which normal production is resumed depends largely upon the existing stage of lactation; recovery being slowest in those animals which have passed their peak of production at the time of vaccination.
VACCINATION OF INFECTED CATTLE

Although the Bureau, has consistently advised that adult vaccination should not be expected to modify the course of the disease in infected animals, reports are frequently received from the field in which some real or fancied benefits from such a procedure are claimed. It was considered advisable, therefore, to re-examine this problem. An opportunity for this was provided by a recent natural outbreak of infection that occurred in a herd located close to the Station. A total of 21 reactor or suspect heifers, ranging in age from 2 to 3 years, were eventually removed from the original infected premises and vaccinated in the regular manner with strain 19 vaccine. Following the initial abortion in the herd, weekly tests were conducted on the rest of the group, and as soon as an animal began showing any reaction to the blood-serum agglutination test, it was promptly removed and vaccinated. Average pre-vaccinal titers for all 21 heifers was 1-150. From the standpoint of pregnancies, 16 of the 21 head were vaccinated at an average gestation period of 151 days. The other 5 animals were open. In the group of 16 pregnant animals, all but 3 aborted as a result of virulent Brucella abortus infection during the same gestation in which they were vaccinated. No evidence of Brucella infection was found in these 3 at the time of their normal parturitions. Of the 5 non-pregnant animals vaccinated, 3 full-term parturitions have been recorded, 2 of which were associated with virulent Brucella recoveries from the udder. The remaining 2 have not as yet calved. Thus, out of a total of 21 heifers vaccinated in early stages of infection, 15 have so far been found to be infected with virulent Brucella abortus at the termination of their first post-vaccinal pregnancies. It is also interesting to note that 5 animals in this group have aborted twice in succession.

From these results, it is apparent that strain 19 vaccination of suspect or reactor animals of the type studied in this experiment has no appreciable effect on the normal course bovine brucellosis would be expected to follow in susceptible non-vaccinated animals.

INTRACUTANEOUS VACCINATION

Various modifications of the original subcutaneous method of administering strain 19 vaccine have been suggested at various times. None, however, has yet been tested adequately to warrant conclusions as to relative values. The intracutaneous method, for example, has, for one reason or another, become more popular in some sections than the research back of its use will justify at this time. The fact that blood agglutinin and opsonin responses are similar to those induced by the usual 5 cc. subcutaneous injections does not, in itself, provide a satisfactory basis for assuming that the method will provide an acceptable degree of resistance in vaccinated animals. Although the exact significance of agglutinins and opsonins has not been determined, it is becoming increasingly evident that the previously accepted usefulness of these elements in judging resistance values has been overestimated in the past. Until such time as improved serological methods are devised for this purpose, reliance will have to be placed on actual controlled vaccination and exposure tests. Even though intracutaneous vaccination may finally
prove to have worthwhile advantages over the subcutaneous method, its unreserved adoption should await the conclusive demonstration of these properties. This proof is not yet available.

CONTINUED RESEARCH ESSENTIAL

Although I have stressed mainly the research, both past and present, that has gone into the development and application of vaccination with strain 19, it is not intended to overlook the brucellosis work that is being carried out along other lines. As a matter of fact, it is only through close collaboration of workers in various fields of research that maximum progress in this, as well as related problems, can be expected. Strain 19 vaccine itself, is by no means the perfect immunizing agent that could be desired, and it will only be through continued research that hopes for the development of a better product can be maintained. Evidence of continuing efforts in this connection are seen in the reports coming from studies of entirely new types of Brucella vaccines now being made at Michigan State College and the University of Pennsylvania.

DESICCATED BRUCELLA ABORTUS VACCINE

The possibility of adapting the process of vacuum drying from the frozen state (lyophilization) to the production of Brucella abortus, strain 19 vaccine, has received increasing attention during the past few years. From preliminary studies, it has been found that a variety of bacterial vaccines, including Brucella abortus, will, when prepared in this manner, withstand temperature ranges that quickly destroy the viability of liquid suspensions. Although many immediate advantages are recognized for the present procedure, initial losses of viability sustained during the actual drying are, so far excessively high. This is especially true in Brucella cultures, where variable losses ranging from 40 to 80 percent are not uncommon. There is reason to believe, however, that eventual determination of the optimum moisture level for dried cultures will reduce viability losses to a point that will greatly expand the usefulness of this procedure. There is no evidence at this time, that the antigenic qualities of viable strain 19 cells are changed by lyophilization.

CHEMOTHERAPY IN BRUCELLOSIS

Revived interest in the treatment of established Brucella infections has paralleled the rapid strides made during recent years in developing new agents. Prominent among these materials are the sulfonamides and an ever increasing range of antibiotics. Sulfanilamide and its various derivatives have been exhaustively studied for their effect on Brucella infections, and while results have been variable in human cases, bovine brucellosis has shown no appreciable response to extended treatments. Investigations of the newer antibiotics, including penicillin and streptomycin, for their value in livestock diseases have been handicapped during the war period by restrictions placed on the distribution of limited supplies. However, the results of such studies as have been possible are not too encouraging in either case. Of the two, streptomycin seems to be considerably more effective against Brucella infection than penicillin. The action of both against Brucella
abortus is primarily bacteriostatic rather than lethal. Moreover, the present cost of streptomycin would be prohibitive for its use in large animals even though it is later proved to be more effective than present results indicate.

CONCLUSIONS

In the foregoing, I have tried to describe briefly some of the research that has gone into the development of improved methods for the control of bovine brucellosis. Although progress at times seems to be discouragingly slow, the increasing knowledge concerning the disease that is gradually being assembled should not be underestimated. The inevitable result of continued cooperative efforts on the part of control and research agencies will be a gradual refinement of methods and material that must hasten ultimate eradication. A possible lead, in this connection, may be found in the frequency with which Brucella cross-infections are being identified under field conditions in livestock species that were heretofore considered resistant to other than restricted types. Thus, it may well be that complete control of brucellosis in cattle will not be accomplished until more attention is given to controlling the disease in other animals, especially hogs, goats, and sheep.
HUMAN BRUCELLOSIS

BY WESLEY W. SPINK, M.D.

Professor of Medicine, University of Minnesota Medical School, Minneapolis

It is a pleasure to appear before you this morning and to discuss with you the subject of human brucellosis, which has become a serious problem. We have been interested in this problem for the past ten years. A number of clinical investigations which had been under way had to be curtailed during the war. In returning to this problem after the war, it has been interesting to note the increase in the number of human cases that we are seeing at the University of Minnesota Hospitals. Furthermore, we are observing cases of active brucellosis in returned veterans. Whether the increase in the number of cases represents an absolute rise in the incidence of the disease is difficult to ascertain. This increase is due in part to the interest of the public in brucellosis, and also to the fact that physicians are looking for the disease. I am of the impression that there has been an actual increase in the incidence of the disease in recent years because during the war control measures broke down and more people became exposed to the infection. We are convinced that the medical profession alone cannot eliminate brucellosis in human beings. The eradication of human brucellosis depends upon controlling the disease at its source, namely, in domestic animals. The ultimate solution of the problem is dependent upon a cooperative program involving public health authorities, physicians, veterinarians, livestock producers and farmers.

ETIOLOGY OF BRUCELLOSIS

It is important to emphasize that human brucellosis may be caused by any one of three species of brucella. Each of these species produces different manifestations of the disease. The most common cause of the cases of brucellosis seen at the University Hospitals is Br. abortus. Over 80 per cent of our patients have the disease due to this strain, while the remaining cases are due to Br. suis. Perhaps we see a majority of Br. abortus cases because the patients come from rural areas, and epidemiological studies, in many instances, reveal the presence of Bang's disease in cattle owned by the patients. Br. abortus causes a relatively mild form of the disease, though a chronic and debilitating illness may result. In addition, the relatively avirulent Br. abortus may cause a fatal disease.

Br. suis causes a more serious illness than abortus strains with a tendency to supplicative lesions and chronicity. Individuals working in packing plants have

1 Presented at the fiftieth annual meeting of the United States Livestock Sanitary Association, Chicago, Ill., December 6, 1946.

2 Several of the investigations referred to in this report have been carried out with the aid of a grant from the United States Public Health Service.

3 A part of the supply of streptomycin used for experimental and clinical purposes was obtained through the courtesy of Dr. Chester S. Keef er, Chairman, Committee on Chemotherapeutic and Other Agents, National Research Council.
the disease caused by this species more frequently than persons in a rural, farming population. We have followed a packing plant employee who had chronic brucellosis for ten years. At the end of that time, *Br. suis* was isolated from his gall bladder and from abscesses of the liver.

*Br. melitensis* is responsible for the more serious cases of human brucellosis, and, fortunately, illness due to this species is not very common. However, it is quite significant that Borts and his associates in Iowa have recently isolated melitensis strains from the tissues of hogs. If melitensis strains are present in the domestic animals in Iowa, there is a good possibility that they exist in Minnesota. Since melitensis strains cause the most severe form of illness in human beings, this is a serious problem, and further investigations in Minnesota are under way.

**Epidemiology of Brucellosis**

My associates and I have been investigating the source of the infection in patients seen at the University Hospitals and the observations of others have been confirmed. We are convinced that a major cause of human brucellosis is the ingestion of raw milk obtained from herds with Bang’s disease. We have observed children with active brucellosis and found out that they were drinking certified milk obtained from a herd with Bang’s disease. In several isolated instances in adults, the source of their disease was the drinking of raw, contaminated milk. I stress this point because it represents a source of the disease that can be eradicated by proper pasteurization of milk. The second major portal of entry is the entrance of brucella through small abrasions in the skin and occurs frequently in farmers, veterinarians and employees in stock yards who handle infected tissues, raw milk, and contaminated materials. This source is more difficult to eradicate.

I would like to interpose a few remarks here concerning the possibility that strain 19 of *Br. abortus* may cause human brucellosis. It is stated that strain 19 is relatively avirulent for animals and human beings. On the other hand, we have been impressed following some recent and preliminary investigations by the low virulence of strains of *Br. abortus* isolated from the blood streams of patients. Yet these strains cause a chronic illness in human beings, and if they localize in a vulnerable organ such as on the heart valves, may actually kill the patient. This is true of other relatively avirulent species of bacteria. There is considerable evidence that the chronicity of brucellosis is due to a state of hypersensitivity of the tissues to a product or products of brucella. There are reasons for believing that if an avirulent strain successively invades tissues without necessarily producing suppuration, a state of hypersensitivity and chronic illness may ensue. Certainly, more information is urgently needed concerning the potential dangers of strain 19 for human beings. In our laboratories, we handle strain 19 with the same respect as strains of *Br. abortus* isolated from patients. For the time being, I believe that until more evidence is forthcoming, strain 19 for purposes of animal inoculation, should be administered only by experienced veterinarians, and not by laymen, who may possess a false sense of security.
CLINICAL FEATURES OF HUMAN BRUCELLOSIS

It is quite apparent that the active cases of brucellosis recognized by physicians represent only a small fraction of the total number of individuals whose tissues are invaded by brucella. In other words, a majority of individuals coming in contact with brucella have either no illness or a relatively mild form of the disease which goes unrecognized etiologically. There is little question that a considerable number of patients have the chronic form of the illness that is not readily detected as being brucellosis. Active brucellosis is one of the most difficult diagnoses to make correctly in human beings. That a considerable number of individuals in an endemic area may have had invasion of their tissues without apparent illness is borne out by investigations that we have made in recent years. One study was particularly informative. The vast majority of patients seen at the University Hospitals come from rural areas. Therefore, 533 consecutive ambulatory adult patients attending the out-patient service of the Hospitals were studied. Intradermal tests were performed with a purified protein obtained from brucella on each of the patients. In addition, agglutination tests by the multiple dilution tube method were carried out. It was observed that 19.5 percent of the 533 patients had positive intradermal tests. Of this 19.5 percent, 23.7 percent had demonstrable agglutinins in their blood in a titer of 1 to 40 or greater. Six had titers higher than 1 to 80. It was of interest that 4 percent of 255 individuals with negative intradermal tests had agglutinins in their blood. Of the 104 individuals with positive intradermal tests, 8 were suspected of having chronic brucellosis, but an unequivocal diagnosis was established in only one. In a similar study made in children under 16 years of age, about 10 per cent had positive intradermal tests.

The results of another study may be cited in part. Following the establishment of a definite diagnosis of active brucellosis in every patient entering the University Hospitals, other members of the family are studied. In this manner, it has been surprising to detect bacteriologically the presence of active disease in another member or members of the family, but who were relatively asymptomatic. On the other hand, several members of a family may have been similarly exposed to the disease as the patient, and although immunological evidence of tissue invasion by brucella is apparent, the individuals deny any recent illness. This is well illustrated by the findings in patient F. H., who was seriously ill with brucellosis. Bang's disease was present in a small herd of cattle owned by this family. The details are presented in Table 1.

The foregoing observations indicate how difficult it is for the physician to establish the presence of active disease in individuals with immunological evidence of previous tissue invasion.

The initial symptoms of acute brucellosis may simulate those of an upper respiratory infection. Frequently, these patients are diagnosed as cases of influenza. Usually the physical examination presents no abnormalities. Not infrequently, the patient with chronic brucellosis will present the following story, “I had an attack of flu with aches and pains in my body; chilly sensations; headache; sweats and a little cough. It cleared up in a week or ten days, but since that time I have
HUMAN BRUCELLOSIS

felt weak and tired. I can't carry out my daily duties. I have headaches, nervousness and feel mentally depressed. My appetite is poor and I am constipated.” It is from these individuals, months after the onset of their illness, that we have been

**Table 1.—Results of investigations in family of F. H., who was critically ill with chronic brucellosis and bacteremia (Br. abortus)**

<table>
<thead>
<tr>
<th>RELATION TO PATIENT</th>
<th>AGE</th>
<th>INTRADERMAL TEST (BRUCELLA PROTEIN)</th>
<th>TITER OF AGGLUTININS</th>
<th>BLOOD CULTURE</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Brother</td>
<td>22</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Recently released from Army, no exposure</td>
</tr>
<tr>
<td>2. Sister</td>
<td>26</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Home only weekends, slight exposure</td>
</tr>
<tr>
<td>3. Brother</td>
<td>30</td>
<td>0</td>
<td>1:80</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>4. Brother</td>
<td>18</td>
<td>1+</td>
<td>1:160</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>5. Sister</td>
<td>13</td>
<td>1+</td>
<td>1:80</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>6. Sister</td>
<td>20</td>
<td>2+</td>
<td>1:160</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>7. Father</td>
<td>55</td>
<td>3+</td>
<td>1:160</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>8. Mother</td>
<td>54</td>
<td>3+</td>
<td>1:160</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2.—Analysis of clinical features of chronic brucellosis (University of Minnesota Hospitals)**

**Symptoms observed—in order of frequency**
1. Weakness
2. Sweating
3. Chilliness
4. Generalized aches
5. Headache
6. Cough
7. Anorexia
8. Constipation
9. Nervousness
10. Mental depression
11. Backache
12. Arthralgia

**Signs observed**
1. Fever
2. Splenomegaly
3. Lymphadenopathy
4. Pallor
5. Abdominal tenderness
6. Spondylitis
7. Endocarditis
8. Tenderness over liver
9. Skin lesions
10. Encephalitis and meningitis

able to isolate brucella from the blood. Furthermore, we have been able to follow some of these individuals back to relatively good health, only to demonstrate the presence of brucella in their blood. Table 2 presents the essential features of pa-
tients with the chronic form of brucellosis observed at the University Hospitals. It is to be emphasized that the majority of the patients do not have localizing findings. In other words, brucellosis is a disease marked by a multitude of symptoms in comparison to the paucity of abnormal physical findings. Consider the dilemma that confronts the physician who practices in an endemic area of brucellosis. A large portion of the population is exposed to the disease and have immunological data reflecting this exposure, namely, a positive intradermal test with brucella antigen, and a low titer of agglutinins for brucella. Many patients confront him in his daily routine complaining of feeling tired, weak, nervous and having vague aches and pains. The differential diagnosis between psychoneurosis and chronic brucellosis becomes quite evident. There is no short cut in the diagnosis of chronic brucellosis. Immunological studies should be supplemented with cultures of the blood. Time does not permit an elaboration of the blood culture technique, but we are now obtaining a higher percentage of positive blood cultures in these doubtful cases of brucellosis.

Since patients with chronic brucellosis frequently do not have localizing manifestations of the disease, and cultures of the blood remain sterile, it appeared desirable to determine in some manner the presence of undoubted evidence of the disease. I should like to detail briefly some unpublished observations which we have made in an effort to resolve this problem. It is well known that brucella localize in the organs of the body with abundant reticuloendothelial cells, that is, the bone marrow, liver, spleen and lymph nodes. Therefore, by simple techniques we have obtained small specimens of bone marrow and liver from patients with chronic brucellosis. To fortify our conclusions we selected patients from whom we had previously isolated brucella from blood cultures. These patients, then, were undoubted instances of chronic brucellosis, though they were afebrile at the time the studies were carried out. In several instances, we were able to demonstrate the typical granulomatous lesion of brucellosis in properly prepared sections of material. A section of a small particle of sternal bone marrow is illustrated in figures 1 and 2. These sections were prepared by Dr. Dorothy Sundberg. It is of interest that cultures of marrow particles containing these lesions did not yield brucella. Figure 3 illustrates a section of liver showing a granuloma. Again, cultures of these small biopsied specimens of liver failed to demonstrate the presence of brucella. The pathogenesis of these lesions is now being studied by Dr. A. I. Braude of this department, while the hepatic changes in brucellosis will be described elsewhere by Dr. F. H. Hoffbauer and Dr. W. W. Walker. For the present, the significant feature of these findings is that patients with chronic brucellosis have widespread tissue reactions. Little wonder, then, that they have so many complaints. Figure 4 demonstrates granulomatous lesions found in the spleen of a patient who had chronic brucellosis. Splenectomy was performed in this patient in an attempt to eradicate the "focus" of the infection. Multiple cultures of this spleen remained sterile, and the patient was not improved following splenectomy. Further studies of this nature are in progress which may aid in defining the pathogenesis of brucellosis, and may prove of value in the diagnosis of the chronic form of the disease.
Fig. 1. Section of sternal bone marrow from patient A. S. showing granuloma which contains Langhans giant cell (×250).

Fig. 2. Another section of marrow at higher magnification from patient A. S. illustrating small Langhans giant cell (×850).
Occasionally, patients may have demonstrable localized lesions, which aid in the diagnosis of chronic brucellosis. At the University Hospitals we have en-
countered three patients who have had subacute bacterial endocarditis due to *Br. abortus*. This is a highly fatal complication, although the organisms on the heart valves may be the relatively avirulent strains of *Br. abortus*. It is entirely reasonable to entertain the possibility that strain 19 may localize upon the valves of the heart. Figure 5 illustrates the bacterial vegetations on the heart valve due to *Br. abortus*.

Another site for the localizing of brucella is the spine. We have seen seven cases of spondylitis due to *Br. abortus*. These patients complain of pain over an area of the spine, and roentgenological examination demonstrates a destructive process involving the intervertebral discs and the bodies of the vertebrae. Fortunately, with immobilization of the spine, these patients will recover completely.

![Fig. 5. Vegetative lesion on aortic valve due to *Br. abortus*.](image)

Since pain over the spine, particularly in the lumbosacral area, is a frequent manifestation of chronic brucellosis, careful examination of the spine must be made in order to exclude the presence of brucella spondylitis. Figures 6 and 7 illustrate the roentgenological appearance of this type of complication.

Symptoms referable to the central nervous system are frequently encountered in patients with chronic brucellosis. At the present time, we have a young ranchman from Montana in the University Hospital, who was sent in with the diagnosis of encephalitis. He has no fever but he has weakness of the right side of the body. Agglutinins for brucella were present in his blood in a titer of 1 to 640, but blood cultures remained sterile. However, *Br. abortus* was isolated from his cerebrospinal fluid. In the future, every case of encephalitis should be carefully evaluated,
Fig. 6. Brucella spondylitis of cervical vertebrae due to *Br. abortus*. Illustration on the right represents lesion approximately one month after that on the left.

Fig. 7. Brucella spondylitis of lumbar vertebrae due to *Br. abortus*.
bearing in mind that brucella will cause the disease, and probably more frequently than the literature reflects.

**DIAGNOSIS OF BRUCELLOSIS**

Time does not permit a thorough discussion of this aspect of the disease. In arriving at a correct diagnosis, the physician must correlate epidemiological data, the natural history of the symptomatology, the physical findings, and laboratory data. Brucellosis is a disease where the final diagnosis rests upon information from the laboratory. Intradermal skin tests have the same connotation as the tuberculin reaction. A positive test means that the patient's tissues have been sensitized to brucella, and denotes either a past infection or active disease at the time the test is made. The agglutinin test is a reliable means of screening active disease in the majority of cases. The higher the titer, the more likely the patient has active disease. After careful study, the opsonocytophagic test has been abandoned in our laboratory, as well as the complement-fixation test. Every patient suspected of having brucellosis should have one, and preferably several, blood cultures made in an attempt to isolate brucella.

**TREATMENT OF BRUCELLOSIS**

There is no satisfactory treatment available for brucellosis. In discussing therapy, one must differentiate acute and chronic brucellosis with a demonstrable bacteremia from patients having chronic brucellosis without bacteremia. I believe that considerable confusion has clouded the treatment of brucellosis because in many instances the diagnosis of active disease is in doubt. Only recently, we saw a patient who had chills and fever, and weakness. He had a positive skin test for brucella and agglutinins were present in his blood. He had received a course of treatment with heat-killed brucella organisms. We demonstrated the parasites of malaria in smears of his blood!

My associate, Dr. Wendell Hall, has been evaluating the effect of the sulfonamides on the growth of brucella by means of *in vitro* methods, and in the chick embryo. He has shown that sulfanilamide, sulfadiazine, sulfamerazine and sulfathiazole inhibit the growth of all three species of brucella, and the chick embryo can be protected against lethal doses of brucella with these sulfonamides. Treatment of human cases of brucellosis having a bacteremia with the sulfonamides has been associated with improvement in the majority of cases. But, in several instances, treatment has been followed by a relapse or the bacteremia has not been eradicated.

Patient W. C., a 36 year old worker in a defense plant, exhibits an illustration of a patient having chronic brucellosis, who was treated with what was considered to be a satisfactory response, but follow-up studies revealed a persistence of a bacteremia due to *Br. abortus*. His clinical course is charted in figure 8. This patient was suffering from a suppurative sinusitis, unrelated to an underlying brucella infection. His sinus was drained, and he also received sulfadiazine. About two months after leaving the hospital, he complained of weakness and sweats, and a culture of blood showed the presence of *Br. abortus*. He was readmitted to the hospital, given a second course of sulfadiazine, and felt improved. Approximately a month after leaving the hospital a second time, a bacteremia due to
Br. abortus was again demonstrated. It is of interest that in vitro studies showed this strain of Br. abortus to be quite sensitive to sulfadiazine. The bacteremia finally subsided spontaneously but he still was too weak to work. He was then given increasing doses of heat-killed vaccine, and coincident with this recovered. He is now back at work feeling quite well. The source of this patient's infection was never established.

J. J., a 40 year old male who collected raw milk from farmers for a co-operative creamery, demonstrates an individual who appeared to respond fairly well to therapy with sulfadiazine. His clinical course is illustrated in figure 9. When studied initially in the hospital, he had three consecutive blood cultures positive for Br. abortus. He was then treated with sulfadiazine and coincident with this he became afebrile and felt definitely improved. Although subsequent observations indicated that the bacteremia had been eradicated, he reentered the hospital approximately one month after discharge because of weakness and painful feet. He was given another course of sulfadiazine which was followed by improvement. He has now been working for a year and a half without a relapse. This patient's infection was traced to one dairy from whom he collected raw milk. The farmer also supplied the milk for the patient's family. Bang's disease was present in this herd of cattle. The patient's daughter also had acute brucellosis.

Attention has been devoted recently to the antibiotics as possible therapeutic agents for brucellosis. With but rare exceptions, we have found strains of the three species of brucella to be highly resistant to penicillin. This drug is not recommended for the treatment of brucellosis. Dr. Wendell Hall has observed that 20 strains of Br. suis and 25 strains of Br. abortus are quite sensitive to the action of streptomycin. This antibiotic, like the sulfonamides, will protect the chick embryo against lethal doses of brucella. But thus far, we have been disappointed in the results obtained with streptomycin following treatment of six pa-
**HUMAN BRUCELLOSIS**

**Fig. 9.** Clinical course of patient with chronic brucellosis due to *Br. abortus*. Marked improvement following two courses of treatment with sulfadiazine.

**Fig. 10.** Clinical course of patient with chronic brucellosis due to *Br. abortus*. Failure of streptomycin to eradicate bacteremia.
tients having active brucellosis. Furthermore, therapy had to be discontinued in four of the six patients because of the appearance of the toxic manifestations of fever and skin eruption. The clinical course of P. L., an 11 year old schoolgirl, is illustrated in figure 10. The patient had been ill for six months suffering from intermittent fever, weakness and anorexia. Cultures of venous blood yielded Br. abortus which was sensitive in vitro to streptomycin. She was given a total of 18.25 gm. of streptomycin in nine days. The drug caused an increase in fever and she developed a generalized skin eruption. She had a subsequent dermatitis due to phenobarbital. When the administration of both of these drugs was discontinued, she became relatively afebrile. But it is to be noted that the streptomycin did not eradicate the bacteremia. Subsequent to discharge from the hospital, her blood cultures have remained sterile, although she still has clinical evidence of active disease.

In summary then, there is urgent need for a specific antibacterial agent for the treatment of human brucellosis. The sulfonamides and streptomycin are not entirely satisfactory drugs.

Perhaps the major problem in the treatment of human brucellosis is related to patients with chronic brucellosis but without a demonstrable bacteremia. As related before, these patients are frequently afebrile, but complain of weakness, vague aches and pains, and they are unable to perform sustained physical or mental activity. Since there is some evidence that these patients have varying degrees of hypersensitivity of the tissues to brucella, a common therapeutic approach to this aspect of the disease is to "desensitize" the patients with various preparations of brucella antigen. There appears to be some merit in such a procedure. While several antigenic products are available for use, we are in no position at the present time to present an evaluation of each. This study is now in progress. We have been treating a selected group of patients having chronic brucellosis with increasing doses of heat-killed brucella cells. The patients selected for study have been those in whom a previous diagnosis had been established bacteriologically. In some instances, the results have been quite encouraging, though improvement is gradual, extending over a period of several weeks.

PREVENTION OF BRUCELLOSIS

As I have already stated, the elimination of brucellosis in human beings can only be accomplished by eradicating the disease at its source, namely, in domestic animals. Whether the test and slaughter method or wholesale vaccination of young animals is desirable, require further investigation. It is quite obvious from our experience that the proper pasteurization of milk for human consumption should reduce the incidence of the disease, but, certainly, this prophylactic procedure will not eliminate human brucellosis.
REPORT ON THE COOPERATIVE BRUCELLOSIS CONTROL AND ERADICATION PROGRAM

BY B. T. SIMMS, D.V.M.

Chief, Bureau of Animal Industry, Agricultural Research Administration, U.S. Department of Agriculture

The Congressional Act appropriating funds with which the Bureau of Animal Industry, United States Department of Agriculture, does field work on this problem carries the following item: "Eradicating tuberculosis and Bang's disease: For the control and eradication of the diseases of tuberculosis and paratuberculosis of animals, avian tuberculosis, and Bang's disease of cattle." It seems quite clear, then, that the activities of the Bureau must be directed toward control and eradication. The legality of any other approach might be subject to question. This paper reviews the work which has been done in the past, describes present conditions, and makes suggestions for the future.

REVIEW OF PROGRESS

The cooperative brucellosis control program has recently celebrated its twelfth birthday. During the first 6 years, the program was one of test-and-slaughter. When it was started there were plenty of outspoken pessimists. There were many reasons, they said, why the disease could not be controlled. Among those most frequently mentioned were (1) the diagnostic test for brucellosis is grossly inaccurate, (2) the best and highest producing cows are infected and the test-and-slaughter method will eliminate most of our best breeding stock, (3) the proposed program will reduce our herds so drastically that meat and milk production will fall far below our National requirements, and (4) the cattle owners are not interested and will not cooperate. Had these skeptics reviewed history they would have found that all these reasons had been advanced to show that tuberculosis control and eradication was an impossibility. They would have found, too, that in the United States of America pessimists usually prove to be false prophets.

What progress was made in these first 6 years? From the day the work began there were more requests from cattle owners for tests than could be taken care of by the available field force. It was estimated from the more than 3 million tests made in 1934–35 that about 10% of the female cattle of breeding age in the country were infected. The almost 7 million tests made in 1939–40 indicated that the percentage of infected cows and heifers had been reduced by more than half. There were 346 accredited counties at this time. These represented more than 11% of all the counties and contained about 6% of all the female cattle of breeding age. Total beef production in the country had increased by a little more than 7%, total milk production had gone up about the same percentage, and average butter-fat production per cow had risen to an all-time high of 182 pounds annually.

As was to be expected, all was not smooth sailing for the test-and-slaughter method. Just as was true in tuberculosis control and eradication, so-called problem
B. T. SIMMS

herds were encountered. They followed a similar pattern in the two diseases occurring infrequently among small herds which raised their replacements and more often among large herds which purchased replacements.

In 1940 at the beginning of the second 6 years, Drs. Mohler, Wight, and O'Rear reported to this association the results of extensive field tests with vaccination of calves with strain 19 vaccine. They stated that “in view of the potential possibilities of Brucella abortus vaccine as an aid in the control of brucellosis it appears desirable to amend the program to include calfhood vaccination as an adjunct to the test-and-slaughter method in those States where this procedure is desired.”

Of course, the pessimists, another group this time, were heard again. Among the most frequently expressed criticisms were statements that (1) the vaccinated animals will become spreaders of the disease, (2) the organism will, by mutation, suddenly regain fully the virulence, (3) the organisms will establish themselves in the udders of vaccinates and will be a menace to human health, and (4) the use of vaccine will not result in enough increase in resistance to make the procedure practicable.

Already war clouds were gathering. Farm labor was changing from a surplus to a scarce commodity, and the veterinary personnel of the army was being built up at the expense of the civilian group. Demands for dairy products and beef were increasing, prices of these commodities were rising, and the numbers of cattle in the country were increasing. Large numbers of cows and heifers of breeding age were moving from farm to farm through sales rings and auction markets, some of which lacked adequate veterinary supervision. All these became increasingly important obstacles in brucellosis control as war began and progressed.

In 1944, when the demands for meat and dairy products were insatiable, Drs. Miller, Wight, and Crawford presented a paper before this association, in which vaccination of adult cattle was discussed. Under the heading, “Conclusions”, the following statement was made:

“What procedures, therefore, should be advocated during the present emergency to safeguard the cattle industry against the spread of brucellosis?

“The elimination of reacting cattle should be continued so far as practicable, as every such animal removed means the prevention of exposure to a number of susceptible animals. The limited manpower available, however, precludes the extensive use of the test-and-slaughter method. It is believed that the area plan of control should not be extended at the present time to counties in which the incidence of infection is relatively high.

“We believe that vaccination with strain 19 vaccine is an extremely useful and timely weapon for the control of bovine brucellosis. Calfhood vaccination offers recognized advantages and it is believed that this practice should be encouraged, especially in areas of heavy infection.

“Calfhood vaccination in conjunction with retention of productive reactors to the agglutination test, until vaccinated replacements become available, is a most desirable practice and adapts itself to the necessity for increased production.

“With respect to adult vaccination in herds under the Federal-State control program we feel that the practice should be limited to use in those herds in which there is but slight prospect of other methods succeeding, and in herds of the type
previously mentioned. The persistence of blood titers in adult vaccinated cattle precludes accreditation for indefinite periods.”

That paper, too, caused a great deal of discussion. Some claimed that it damned adult vaccination with faint praise. Others stated that whole-herd vaccination had been enthusiastically endorsed as a panacea for brucellosis.

What progress was made during this second 6-year period? North Carolina became the only accredited State and is still in that status. The number of accredited counties reached a height of 583 in 1943, but with the ever-increasing scarcity of personnel it was impossible to maintain this level. In September of this year 528 counties remained on the accredited list. Slightly less than 5 million official tests were made in the year ended June 30, 1946. This is a decrease of nearly 40% from the high of a little above 8 million in 1938. In some States it seemed advisable to concentrate field work on herds and areas in which there was definite evidence of the disease. This resulted in a marked decrease in retesting of clean herds. Consequently, percentages of reactors obtained in the last 3 or 4 years are not strictly comparable to those of prior periods. From the figures available it seems true that the percentage of infected female cattle of breeding age is still around 5. While this regression during the war period is disappointing, it should not be the cause of too much discouragement. In this connection, attention is called to a similar regression in the tuberculosis eradication program. The percentage of cattle which reacted to the test increased by more than one fourth between 1943 and 1946.

Production of strain 19 vaccine under Bureau supervision increased steadily during this period until in the year ended June 30, 1946 more than 3 million doses were released. It is estimated that at least 2 million heifers are now being vaccinated annually.

This procedure is giving good results when it is used in connection with other recognized disease-control measures, including good sanitary practices. Uninformed people have been disappointed when in some instances the resistance of vaccinated animals was overcome by severe exposure or when some vaccinated heifers continued to react after they reached breeding age. Had they gone to the trouble to look up the available information they would have found records of carefully controlled experiments which gave these same results.

Vaccination of female cattle of breeding age has come into rather wide use in some sections. In many cases, whole-herd vaccination has been resorted to when there was neither clinical evidence nor positive agglutination records to indicate the presence of the disease. It is not unusual to find that such vaccinations have been practiced without the advice of anyone trained in the field of livestock disease control. Needless to say, such procedures go far beyond the recommendations made before this association in 1944 by Drs. Miller, Wight, and Crawford. As might be expected, owners of such herds have seen no improvement following vaccination, but have been rather seriously handicapped when and if they attempted to ship such cattle interstate or to make sales subject to agglutination tests.

On the other hand, evidence continues to be clear-cut that vaccination of mature cattle does increase very materially resistance against the infection.

During this second 6-year period the number of cattle in the country increased materially, total beef production increased over 20%, total milk production in-
creased about 11%, and the average butterfat per dairy cow will probably be about 193 pounds this year, again an all-time high.

The average butterfat production per cow per year for the three years 1932–34 was 164 pounds. This rose to an average of 185 pounds for the years 1943–45. The average increase per cow was 22.5 pounds per year in the 23 states in which official records showed the greatest decrease in percentage of brucella-infected cattle, while it was only 16.7 pounds for the 23 which showed the least decrease in percentage of reacting cattle. In 2 States there was insufficient testing to obtain a reasonably accurate estimate of the percentage of infection. It is realized that the brucellosis testing records include only a portion of the cattle in each State, but it is believed that they are sufficiently voluminous in these 46 States to be fairly accurate.

CONDITIONS AT PRESENT

What is the picture today? Brucellosis continues to be one of our most serious cattle diseases; serious from both an economic and a public-health standpoint. Infection with brucellosis is still accompanied by a decrease of from 10 to 30 percent in production of both live calves and milk and by increases in breeding troubles, mastitis, and arthritis. Attention is called to the fact that only a small part of the gross income of any cattle enterprise is profit and that a relatively small decrease in gross income usually completely wipes out all net income. Usually, all that is necessary to convince the doubting owner of the effect of this disease on the economy of production is to persuade him to separate his herd into infected and brucellosis-free groups. He soon realizes that the infected herd is unprofitable and disposes of it. Most veterinarians who have worked with this disease in the field have seen this happen.

The public-health aspect of bovine brucellosis is being emphasized more and more. While accurate information is not available as to either the total number of undulant fever cases in our population or the percentage of these that are caused by the bovine type of the organism, it is generally accepted that both the consumption of infected milk and contact with infected cattle are sources of danger to our population. Some workers have estimated that about 50% of all cases of undulant fever are milk borne.

The livestock sanitary officials, the veterinarians, and the owners and the breeders of cattle must accept the responsibility of protecting our people from exposure to bovine brucellosis. Some have suggested that this can be done by pasteurization of milk. Analytical thinking will show, however, that this statement is fallacious.

The Bureau of Census records for 1940 show that about 40% of our population is living on farms or in unincorporated towns. Another 10% is living in towns with less than 5,000 inhabitants, and still another 10% in towns and cities of between 5,000 and 25,000 inhabitants each. Since only a very small percentage of the rural population and a relatively small percentage of the people living in villages and small towns drink pasteurized milk and cream it seems conservative to estimate that approximately half of our milk and cream consuming public more or less regularly consumes unpasteurized dairy products. It does not seem likely that this situation will change materially in the near future. Furthermore, contact exposure of people handling infected cattle can not be prevented by pasteurization of milk. No, pasteurization, although an important and desirable procedure, is not the answer.
Protection of our people from exposure to Brucella abortus can come only through elimination of infected animals.

**Suggestions for Future**

What of the future? So far as the Bureau is concerned our objective has not changed. To quote Drs. Miller, Wight, and Crawford: "It is our aim to eliminate brucellosis from our cattle population." In order that we may realize the size of this job, attention is called to the following figures. There are approximately 40 million female cattle of breeding age in this country. We raise about 10 million heifer calves each year. If 5% of the cattle of breeding age are infected, we have about 2 million cattle carrying Brucella infection in this country. Probably less than 7 million of the disease-free cattle have been vaccinated. We have, therefore, about 30 million female cattle of breeding age in this country which are free from brucellosis, but susceptible to this disease. Approximately two thirds of our female cattle are kept for dairy purposes. Since the percentage of infection in dairy and beef animals does not appear to be significantly different we probably have about one and one third million infected dairy cows and heifers and about two-thirds million infected beef cattle. About half of the milk produced in this country is consumed as fluid milk or cream. Since approximately half of this is not pasteurized, about one-fourth of the infected dairy cattle or one-third of a million of them furnish raw milk and cream to our people.

Conditions have changed considerably in the last 2 years. Our civilian veterinary personnel has regained most of its members who served in the armed forces. All-out production of beef and dairy products is being replaced by a program of economical production. With most of our herds up to optimum or even maximal size, owners are again doing some culling. Our cattle population which increased steadily from 1938 finally reached a peak and has declined slightly in recent months.

What were logical reasons for not enlarging the brucellosis eradication and control program are becoming rather poor excuses. We can now increase the vigor and the scope of our attack without endangering to the slightest degree our overall food production.

Since we still know of no successful treatment, we must continue to devote all our efforts to prevention of spread of the disease. Again requoting Drs. Miller, Wight, and Crawford: "The elimination of reacting cattle should be continued so far as practicable, as every such animal removed means the prevention of exposure to a number of susceptible animals." Still requoting: "We believe that vaccination with strain 19 vaccine is an extremely useful and timely weapon for the control of bovine brucellosis. Calfhood vaccination offers recognized advantages and it is believed that this practice should be encouraged, especially in areas of heavy infection." But it oversimplifies the problem to say either that the 2 million infected cattle should be slaughtered and replaced by disease-free heifers or that all the heifers we raise each year should be protected by vaccination. The 5 million official tests being made annually do not include more than 12 or 13 percent of our total number of female cattle of breeding age. Manifestly, even if the test-and-slaughter method were perfect this volume is too small to be very effective from an overall standpoint. If every dose of strain 19 vaccine which is produced was injected while still fully potent and every heifer so injected was completely immunized
for life we could never, at the present rate of vaccine production, expect to have more than about one third of our cattle protected. This, also, is too small.

The quantity of our work must be increased. This, of course, means increased personnel. Where will enough men to do this job be found? Since it seems improbable that any material increase in the size of the field forces of either the Bureau or the States can be expected in the near future, the first thought is the practicing veterinarians. In some States they are already doing a very considerable part of the work by serving as part-time employees of their respective States or counties. We would suggest that those State Officials whose personnel remains depleted give serious consideration to this possibility. And at the same time we would ask the practitioners who are offered such part-time appointments to accept and to help with the job at hand.

The quality of the work needs serious consideration, too. With 12 years of experience behind us it seems worthwhile to analyze the different methods of approach, survey the results, and try to determine why the program has been more successful in some States than in others. This has been discussed with Bureau employees, State veterinarians, their assistants, and practicing veterinarians at the different brucellosis conferences which were held recently. From these men who are in close contact with the problem came many suggestions and constructive criticisms which can be heeded to advantage. Probably the one factor which they emphasized most was the attitude of the cattle owners. “The producers want this program” was heard time after time from workers in whose States brucellosis control is making good progress, while “many of our owners are not interested” was reported from those areas in which results have been less satisfactory. Closely allied with this was the question of the scope of the work. As has been demonstrated in our other disease-control programs, attack on the area basis has usually been much more satisfactory than has attack in individual herds. Area work is, of course, practicable only when most of the owners support it.

Some other statements concerning owners were more specific. More than one field worker pointed out the frequency of introduction of the disease into clean herds through the purchase of untested cows. In fact, one man stated that the clean herd was the problem herd because in so many instances the owner failed to realize the part he must play in keeping out the disease. Too often owners of brucellosis-free herds have been led to believe that they are sitting on powder kegs, but have not been told that if there is an explosion it will probably be the result of their applying the match.

Both the owners and the livestock sanitarians should recognize the fact that any disease-control program is a cooperative project. Both groups should realize that the general public is interested in the brucellosis program. In those States in which owner cooperation and support are lacking it is advisable to do additional fundamental educational work. The extension service, the public health officials, the practicing physicians, and the farm organizations are usually more than willing to assist in arranging for meetings, disseminating information, and arousing interest.

Many field workers at the conferences previously mentioned emphasized the necessity of doing the technical job in a scientific and a professional manner. “The man who looks on his job as bleeding cows or injecting vaccine”, they said,
“becomes just a bleeder or a vaccinator rather than a successful livestock sanitarian.” The more important of their suggestions concerning the technical job have been circulated to inspectors in charge in the several States. Since copies are available they will not be repeated here.

We would emphasize the complexity of brucellosis in cattle and the fact that any successful fight against it taxes the ability and the ingenuity of everyone concerned. Experience has shown rather clearly that control procedures which give good results in some herds may not be so successful in others. It is shown, too, that many of the so-called problem herds can be handled successfully if enough attention is paid to the details of the program.

No livestock disease has ever been eradicated until the carriers were either destroyed or restricted in their movement. Permanent identification and either quarantine or slaughter of infected cattle should surely be considered a basic requirement in any cooperative control and eradication program.

All disease control and eradication programs which have been successful in this country have operated under a well-organized plan carried out systematically under the direction of personnel trained for this purpose. It has always been necessary to continue our fight against such diseases long after the average owner felt his herd had been freed from the infection. Plans for the future of the brucellosis program should include provisions for this.

On the whole we feel that good progress has been and is being made and that, although the job is stupendous, we have reason to be optimists.

SUMMARY

1. Brucellosis continues to be one of the serious infectious diseases of cattle in this country.
2. Although good progress has been made in the past the program must be enlarged if the disease is to be controlled and eradicated.
3. More personnel is necessary if the program is to be enlarged.
4. The control and eradication of this disease require the full cooperation of the cattle owners and the livestock sanitarians.
5. Cattle owners should be fully informed as to the part they must play in the program.
6. When circumstances permit, the area method of attack is the one of choice.
7. The test-and-slaughter method, when properly applied, continues to give good results, especially in small or medium size herds which raise enough heifers for replacement.
8. Vaccination of heifers continues to be a valuable adjunct in infected herds or areas. In large, heavily infected herds, especially in those in which it is necessary to purchase some replacements and in problem herds, vaccination of heifers with temporary retention of reactors is being used with success. In all such herds the final goal should always be a brucellosis-free herd.
9. While it is well recognized that vaccination of female cattle of breeding age is followed by increased resistance to the disease the disadvantages of this procedure are such that “under the Federal-State control program we feel that the practice should be limited to use in those herds in which there is but slight prospect of other methods succeeding.”
REPORT OF COMMITTEE ON BRUCELLOSIS


Your Committee on Brucellosis, after serious study and consideration of the various topics suggested for this year's report, and after carefully reviewing the reports on brucellosis as presented and accepted by this Association in the years 1943–1944–1945, recommend that these reports serve as a guide in formulating policies for the control and eradication of brucellosis in the several states.

Your Committee further recommends that the Bureau of Animal Industry, experiment stations, and all other interested agencies expand and coordinate their efforts in the study of brucellosis.
REPORT OF COMMITTEE ON LAWS AND REGULATIONS


The report of this Committee consists largely of a summary of the results of various sectional meetings made up of groups of states so arranged that the United States was divided into six sections. These meetings were called for the purpose of discussing and approving, if possible, the uniform interstate regulations drawn up by the 1944 Committee.

Eleven western states, namely, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming met at Salt Lake City, Utah and unanimously adopted uniform regulations to suit that locality. On horses, purebred and dairy cattle, the regulations are not materially different from the uniform ones drawn up by the 1944 Committee. Briefly, the exceptions are as follows:

- Purebred swine, in addition to accepted immunization to hog cholera, must be negative to a brucellosis test within thirty days of shipment. All swine to be shipped in clean and freshly bedded cars, or trucks, or by express in crates.

- All dogs except performing dogs must be vaccinated with rabies vaccine not over six months prior to date of shipment.

- Range and semi-range cattle are exempted from brucellosis tests. Calves officially vaccinated between four and eight months of age may be shipped on clinical health certificates, until eighteen months old, whether from infected or clean herds.

- Mature purebred animals vaccinated with brucella abortus vaccine, by a licensed graduate veterinarian, and which gave a negative reaction to an official blood test for bovine brucellosis at the time of vaccination, may be imported on special permit in writing, provided they go into a herd of like status. Individual identification of vaccinated animal is required.

The central states comprising Arkansas, Kansas, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota and Texas, met at Omaha on August 8th. Six of these states were represented at this meeting, namely, Arkansas, Kansas, Missouri, Nebraska, Oklahoma and South Dakota. Their recommendations, following a thorough discussion of the uniform interstate regulations of the 1944 Committee, follow almost identically the pattern set at the Salt Lake City meeting of the western states.

It is the opinion of your Committee that this entire western group of states can easily get together on uniform regulations, as there is a unanimous agreement at present of eleven and practical agreement of seven, making a total of eighteen. This would include all states lying west of the Mississippi River, except Iowa, Louisiana, Minnesota and North Dakota.

The uniform regulations as drawn by the 1944 Committee seem to have been
adopted, with few exceptions, by Alabama, Delaware, Florida, Illinois, Indiana, Iowa, Louisiana, Maryland, Michigan, Minnesota, Mississippi, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia and Wisconsin, leaving only seven states that have done little or nothing to make their interstate regulations conform with the 1944 Committee suggestions.

It is the opinion of your Committee that the work on uniform laws and regulations should be continued so that the few states which have not made any changes in their regulations may have an opportunity to do so. The fact that eighteen of the western states are practically in agreement on interstate regulations, and that nearly all of the other states can endorse the regulations adopted by the 1944 Committee is heartening indeed, and is the first promise we have had that we may some day be in a position to write one regulation for the entire United States.

Your Committee was asked to draw a more comprehensive regulation governing the interstate movement of poultry, and the following regulation is presented for your approval. The general text is patterned after a recent regulation made by New Hampshire and the section covering pullorum disease was taken from the report of the National Committee on pullorum disease.

POULTRY AND BIRDS OF ALL SPECIES

Chickens, turkeys, or other poultry over five months of age intended for breeding purposes shall not be imported into this state unless they have passed a negative agglutination test for pullorum disease under the supervision of a state livestock sanitary authority within thirty days preceding date of importation, or have originated from flocks authoritatively participating in such pullorum control and eradication phase of the National Poultry Improvement Plan or National Turkey Improvement Plan as may be adopted in this state.

All poultry under five months of age, including baby chicks, started chicks, turkey poults, other newly hatched domestic poultry, except those intended for immediate slaughter, and hatching eggs shipped or otherwise brought into or offered for sale in this state shall have originated in flocks that meet the pullorum requirements of the National Poultry Improvement Plan or the National Turkey Improvement Plan, and the regulations issued by authority of this Act. Every container of such poultry shall bear an official label or certificate showing the name and address of the shipper, the authority under which the testing for pullorum was done, and the pullorum control and eradication class of the product, the use of said certificate or label to be approved by the official state agency or the livestock sanitary official of the state of origin.

No truck or other conveyance, or boxes, crates or containers which have been used for the shipment of poultry, or birds of any species, shall be used for the shipment of poultry or birds of any species into this state unless such truck or other conveyance, or boxes, crates or containers have been first thoroughly cleaned and disinfected.

Owners of flocks where live vaccine or active virus has been used must not ship birds into this state without first obtaining special permit to do so from the live-
In applying for such special permit, give complete information as to why, when and how vaccine or virus was used.

Blanket certificates will be issued to hatcheries filing proper applications. Single certificate forms may be obtained by writing the state livestock sanitary department. If shipper furnishes the certificates they should be in the following form:

**Certificate Covering Shipment of Poultry, or Birds of Other Species, into the State of**
REPORT OF COMMITTEE ON RESOLUTIONS


Resolution No. 1—To Hon. Clinton P. Anderson:
WHEREAS, it has been brought to the attention of the United States Livestock Sanitary Association that Brahman cattle have been imported into the Republic of Mexico from a country in which foot and mouth disease exists or frequently occurs, and
WHEREAS, these importations and others contemplated constitute a distinct hazard to the health of livestock of Mexico and thence particularly to the livestock of the United States; therefore, be it
Resolved: That the United States Livestock Sanitary Association respectfully requests that your office take such action as necessary to eliminate this threat to the livestock of the United States.

Resolution No. 2:
WHEREAS, there is an increasing number of articles appearing in the lay press misrepresenting recognized programs and/or scientifically established facts regarding livestock disease control procedures; therefore be it
Resolved: That this Association create a Publicity Committee and authorize said Committee to answer any articles of misrepresentation or attacks.

Resolution No. 3:
WHEREAS, scientific advancement in the prevention and control of communicable diseases is dependent upon extensive research and investigation, and
WHEREAS, it appears further research of a comprehensive character is necessary to properly evaluate and apply the present known measures in the control of bovine brucellosis; therefore be it
Resolved: That this Association recommend and urge the Chief of the United States Bureau of Animal Industry to call the key research men of America together to study and analyze this problem, and coordinate the research somewhat along the lines and purposes of the Avian Pneumencephalitis Conference held in Baltimore recently.

Resolution No. 4:
Resolved: That all serums, viruses and other biologics be produced under authority of a license issued by the United States Bureau of Animal Industry; and, further,
That this Association request the United States Bureau of Animal Industry to exercise its authority over the interstate shipment of all such products that contain a living organism capable of producing disease in animals, and prohibit the interstate movement of such products in violation of the laws or regulations of the state of destination.
Resolution No. 5:

WHEREAS, it appears there is insufficient time outside of general session hours for the various committees to meet, study, analyze, coordinate material, and accomplish creditable reports; therefore be it

Resolved: That all committees meet during the afternoon of the day just preceding the opening of the Association meeting.

Resolution No. 6:

WHEREAS, the uncontrolled interstate movement of livestock by trucks is becoming a menace to the livestock disease control programs now being carried on by the several states in cooperation with the federal government, and

WHEREAS, the state livestock sanitary officials of the various states are unable to effectively enforce the laws, rules and regulations governing the interstate movement of livestock transported by trucks, and

WHEREAS, in the interstate movement of livestock by railroads the laws, rules and regulations can and are being enforced because rail movements must be accompanied by a properly accomplished Official Interstate Health Certificate approved by the proper state or cooperating federal official; therefore, be it

Resolved: That the Hon. Clinton P. Anderson, Secretary of the United States Department of Agriculture, be requested to promulgate such rules or regulations as will make an official Interstate Health Certificate a prerequisite to the interstate movement of livestock by trucks; and be it further

Resolved: That the Hon. Clinton P. Anderson, Secretary of the United States Department of Agriculture, be requested to amend Regulation 7, Bureau of Animal Industry, Order 309 Revised, pertaining to the interstate movement of cattle, regarding tuberculosis, to include similar and appropriate restrictions covering bovine brucellosis.

Resolution No. 7:

Resolved: That no further regulations be promulgated by the several state livestock sanitary officials concerning the control of avian pneumoencephalitis other than upon scientific findings.

Resolution No. 8:

WHEREAS, Dr. A. E. Wight, a member of this Association since 1909, elected President in 1930, retired from his position as Chief of the Tuberculosis Eradication Division of the Bureau of Animal Industry, U.S. Department of Agriculture, May 1, 1946; therefore be it

Resolved: That we hereby acknowledge the long and faithful service rendered by Dr. Wight, and express our appreciation of his ever willing and helpful cooperation, and further we extend the wish of many more years of continued health and enjoyment.

Resolution No. 9:

Resolved: That we hereby reiterate the objection of the Association to any relaxation of import regulations that would subject the livestock industry of the United States to the introduction of any diseases that are not indigenous to this country.

Resolution No. 10:

WHEREAS, the Pan American Sanitary Bureau has given consideration to the need of establishing a Section of Veterinary Medicine within the Pan American Bureau; therefore be it
Resolved: That we reiterate the endorsement of the United States Livestock Sanitary Association to the move which will provide for better international veterinary relations.

Resolution No. 11:
WHEREAS, the United Nations Organization has appointed a committee to form an internal health organization; therefore be it

Resolved: That the United States Livestock Sanitary Association express its approval of the formation of a Section on Veterinary Medicine as an integral part of this council.

Resolution No. 12:
WHEREAS, in the presentation of the program of the United States Livestock Sanitary Association the services of men known to be qualified in their respective fields of activity are required, and

WHEREAS, these gentlemen receive no compensation for their labors, but contribute freely and graciously of their time and effort; therefore be it

Resolved: That the United States Livestock Sanitary Association convey its sincere thanks and assurance of appreciation to each speaker on the program for his helpful assistance, and that the Secretary so inform him.

Resolution No. 13:
WHEREAS, there exists in the United States an infectious disease of poultry variously known as avian pneumoencephalitis, Newcastle disease, avian pest and perhaps by other names, and

WHEREAS, coordinated research and control has been inaugurated with a view to the eradication of this disease of poultry from the United States, and

WHEREAS, in this nationwide cooperative effort there is advantage in a single name for a single disease entity, therefore, be it

Resolved: That the official name of this disease adopted by this association and the name used in all of its official publications shall be Avian Pneumoencephalitis, that being the more scientific of the names so far proposed and the only one indicating the class of animals affected, the pathological process involved and the symptoms presented by the affected bird.

Resolution No. 14:
WHEREAS, there are certain parts of papers presented on our programs that are of public interest and value, and

WHEREAS, such matters, if given wide publicity, will assist in educating the public to the importance of control of livestock disease, to an assured food supply, to the economic welfare of the nation and to public health, therefore, be it

Resolved: That the president be instructed to appoint a committee on public relations whose duty it shall be to compile appropriate releases and supply them to the news services daily during our annual meetings, and be it further

Resolved: That those contributing to our programs be respectfully requested to give the committee on Public Relations such assistance as they conveniently can to the end that its releases may be authoritative and timely.

Resolution No. 15:
Resolved: That the United States Livestock Sanitary Association hereby express our appreciation to the manager and employees of the Stevens Hotel for the satisfactory accommodations they have provided for our meeting. We are particularly
grateful of the services rendered at this meeting in view of the difficult situations confronting all hotels in Chicago at this time; and be it further

Resolution No. 16:

Resolved: That the President and Secretary-Treasurer of this Association be and are hereby authorized to supply copies of the foregoing resolutions to the appropriate persons, and by letter direct their attention to these resolutions.

REPORT OF THE NOMINATING COMMITTEE

The Auditing Committee is pleased to report that they have carefully audited the books and financial transactions of the association conducted by its Secretary-Treasurer and find the accounts kept in an orderly and businesslike fashion and correct as presented in the report of the Secretary-Treasurer.

Respectfully submitted,

(Signed) J. V. KNAPP
T. C. GREEN
J. R. SNYDER
REPORT OF THE NOMINATING COMMITTEE

Dr. R. W. Smith: The nominating Committee, composed of your speaker, Ralph West of Minnesota, and A. J. Carr of California, have canvassed the members of this Association. We have taken into consideration the geographical locations of the list of officers we wish to present for your consideration, and we place in nomination the names of Mr. Will J. Miller, Topeka, Kansas, for President. Dr. J. V. Knapp, Tallahassee, Florida, as First Vice President. T. O. Brandenburg, Bismarck, North Dakota, Second Vice President. Charles P. Bishop, Harrisburg, Pennsylvania, Third Vice President.

ELECTION OF OFFICERS

If there are no further nominations, I move that the Secretary cast one ballot for the names as read.

The motion was severally seconded.

President Moore: Are there any other nominations? If not, we will vote on the motion.

The motion was put to a vote and was carried unanimously.

INSTALLATION OF OFFICERS

President Moore: Next is the induction of officers. Here they are, a fine looking group. (Applause)

Will, it gives me great pleasure to turn this gavel over to you and wish you much success in the coming year. I hope it will be as much pleasure for you as it has been for me to take part and direct these deliberations. (Applause)

Mr. Will J. Miller assumed the Presidency.

President Miller: Thank you, Dr. Moore. I want to say that this is considered by me to be a wonderful honor. I know my many friends have made this possible. Again I wish to thank them and say I will try to carry on to the best of my ability to make the United States Livestock Sanitary Association a bigger and better organization. Thank you. (Applause)

It is my pleasure now to introduce our First Vice President, Dr. Knapp of Florida. (Applause)

Dr. Knapp: President Will, second and third Vice Presidents, Secretary-Treasurer and gentlemen: It will be my pleasure to assist our President and officers and members in carrying out the activities of this Association to the best of my ability. Thank you. (Applause)

President Miller: Thank you, Dr. Knapp.

It is my pleasure now to introduce to you our Second Vice President, Dr. Brandenburg of North Dakota. (Applause)

Dr. Brandenburg: Gentlemen, it is my understanding that the Vice President is merely a man who stands by in case the President should suddenly die. (Laughter) Since my good friend Will Miller looks very healthy, and also my friend from Florida, Dr. Knapp, I am quite sure my duties are going to be quite light. How-
ever, I will be pleased to assist Mr. Miller in putting over the greatest year this organization has ever had. With Mr. Miller at the helm I am sure it can be done. Thank you. (Applause)

President Miller: Thank you very much, Doctor.

It is always a pleasure to introduce somebody who is almost as fleshy as I am, so it's a pleasure to introduce our Third Vice President, Dr. Bishop of Pennsylvania. (Laughter and Applause)

Dr. Bishop: It is certainly an honor to be elected as an officer of this Association. I assure you, Mr. President and members, that I will do my best to carry on and try to promote the interests of this organization. Thank you. (Applause)

President Miller: I do want to say before you leave, Dr. Moore, that you have made a grand President, and your efforts have certainly been appreciated by this body.

We stand adjourned.

The meeting adjourned sine die at 12:10 P.M.
FIFTY-FIRST
ANNUAL MEETING
TO BE HELD
HOTEL LA SALLE
Chicago, Illinois
Dec. 3, 4, 5, 1947