Proceedings
FIFTY-EIGHTH
ANNUAL MEETING
of the
UNITED STATES LIVESTOCK SANITARY ASSOCIATION

HOTEL FONTENELLE
Omaha, Nebraska
November 10-11-12, 1954
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United States Livestock Sanitary Association

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BIOLOGICS AND PHARMACEUTICALS


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<th>Plate of Meeting</th>
<th>President</th>
<th>Secretary</th>
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<td>1. Sept. 27-28, 1897‡</td>
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<td>*Mr. C. P. Johnson, Springfield, Ill.</td>
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<td>2. Oct. 11-12, 1898</td>
<td>Omaha, Nebraska</td>
<td>*Mr. C. P. Johnson, Springfield, Ill.</td>
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<td>5. Oct. 8-9, 1901</td>
<td>Buffalo, New York</td>
<td>*Dr. E. P. Niles, Virginia</td>
<td>*Dr. F. T. Eisenman, Louisville, Ky.</td>
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<td>*Dr. W. J. Butler, Helena, Montana</td>
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<td>Place of Meeting</td>
<td>President</td>
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<td>50. Dec. 4-5-6, 1946</td>
<td>Chicago, Ill.</td>
<td>*Dr. William Moore, Raleigh, N. Carolina</td>
<td>Dr. R. A. Hendershott, Trenton, N. J.</td>
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<td>51. Dec. 3-4-5, 1947</td>
<td>Chicago, Ill.</td>
<td>Mr. Will J. Miller, Topeka, Kansas</td>
<td>Dr. R. A. Hendershott, Trenton, N. J.</td>
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<td>53. Oct. 12-13-14, 1949</td>
<td>Columbus, Ohio</td>
<td>Dr. T. O. Brandenburg, Bismarck, N. D.</td>
<td>Dr. R. A. Hendershott, Trenton, N. J.</td>
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<td>57. Sept. 23-24-25, 1953</td>
<td>Atlantic City, N. J.</td>
<td>Dr. T. Childs, Ottawa, Canada</td>
<td>Dr. R. A. Hendershott, Trenton, N. J.</td>
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<td>58. Nov. 10-11-12, 1954</td>
<td>Omaha, Neb.</td>
<td>Dr. T. C. Green, Charleston, W. Va.</td>
<td>Dr. R. A. Hendershott, Trenton, N. J.</td>
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* Deceased.
† This was the last meeting of the Interstate Association of Livestock Sanitary Boards.
‡ Reprinted in 54th Annual Report.
WELCOME TO NEBRASKA

HONORABLE ROBERT B. CROSBY
Governor of Nebraska

Thank you very much.

Let me apologize for breaking into the regular order of your program this morning, as I see I have done through the courtesy of your presiding officer.

I notice you are somewhat behind on your schedule this morning. I don’t know just what may have occurred last night that got you off to a late start this morning, but I will assist you by making my remarks shorter than the program anticipated as printed.

I wish I could have been here yesterday morning to extend Nebraska’s welcome at a time when it ought to have been given to you; but since I could not be here yesterday, I come today and want to say with just as much emphasis as I can that Nebraska is very happy to be your host at this Association meeting.

We are particularly happy, because the livestock industry is the biggest industry in Nebraska. As some of you may know, we produce more cattle than any other state in the United States except one. You are meeting here in Omaha where our livestock market in some lines and on some days is the biggest livestock market in the world.

Let me tell you a little about Nebraska so that you can see why livestock is so important to us, those of you who come from other states and who may not have the exalted idea about Nebraska that I want you to have. [Laughter]

We are a State that is extensive in area, with about 76,000 square miles, almost 500 miles in length. What many people don’t know about Nebraska is that there is a great agricultural variety from the west end to the east end. If you happened to come into Omaha by air you landed at an airport that is 985 feet above sea level.

Nebraska is a rather flat State, but it is tipped. If you go to the west end you find altitudes from 4,000 to 5,000 feet. The consequence of that is that in the eastern third of Nebraska or the eastern half of Nebraska we have a very large production of corn, a good many other types of livestock feed, so that it is a great cattle feeding and cattle finishing area in the eastern half of the State.

In the western half of the State, in the sandhill portion, we have what I think it a very unique type of soil and type of grass. You are probably all familiar with it. This makes possible some of the finest ranches in the world.

I had an interesting visit just recently with one of our livestock auction sale barn men, one of the oldest in the State in point of time that he has been operating his business. He was telling me about an argument that had been going on for two or three years between himself and his son. My friend’s thesis was this:

My friend, the livestock auction sale barn man, claimed that the prosperity of the United States depended upon livestock. He argued this way: Most of the agricultural production from the soil was fed to livestock. He said that the agricultural production from the soil and its sale determined the prosperity of the agricultural
part of the United States. He said that the prosperity of the farmer determined everyone else's prosperity, because if the farmer could not buy industrial products, if he could not buy all of the other products of the nation, then there was bound to be a slump.

His son argued that the prosperity of the nation depended upon employment and employment conditions. I don't suppose they will ever decide that particular argument, but at least it is interesting to notice that you can make a pretty good argument that the prosperity of the entire United States depends upon livestock.

Here in Nebraska we have had some problems that may be of interest to you. I haven't been here long enough to inquire about the precise nature of all of you who are attending this meeting. Let me tell you a little bit about our problem with regard to veterinarians in Nebraska.

To begin with, we don't have enough veterinarians. Secondly, we don't have a veterinary college. Our young people have had to get their veterinary education in other states. The enrollment in the veterinary colleges in the Midwest is usually filled up very quickly, and beside that it is pretty expensive to go to another state and pay the nonresident tuition fees in a veterinary college.

We are solving that perhaps a little late in Nebraska, but we are solving it in the way other states have solved it. Our Chancellor announced the other day (the Chancellor of our State University) that he intended before the beginning of the next term to make contractual arrangements so that our young men and women (and I know one very charming lady veterinarian) will be able to get an education in the veterinary college of some adjoining state, with the same advantages tuition-wise as if we had a college in this State.

Let me tell you something about cattle men as I think about them, and then I will quit speaking. Perhaps I have emphasized the cattle part of it too much. It has been nothing short of amazing to me, as a man in public office and as one who is naturally interested in politics, to notice how determinedly in Nebraska our cattle men's association has resisted the idea of cattle supports. Perhaps you can explain what there is about producing cattle and livestock that develops a very independent and anti-government-control state of mind.

Let me say to you that it is a very refreshing thing to observe. In this day and age, when it is pretty easy for politicians back East (and some of you come from the East) to get to think that all of the agricultural Midwest is just panting with desire to have the government support it, it is pretty refreshing to see one segment of the agricultural economy (and it is true right across Nebraska) stubbornly against government price supports for their particular commodity, stubbornly against controls, and taking that position in the face of the fact that the corn and other basic commodities that they buy to feed cattle are under farm price supports.

I mention that to you as one of the things I have admired greatly about the livestock industry of Nebraska. It spreads over into a good many other states. Regardless of your political point of view, I think you will agree with me that it is pretty good to find a complete industry group of livestock people in this State wanting nothing more than to stand on its own feet in a free market, under a free enterprise system, and telling Uncle Sam to spend his money elsewhere.
I hope that while you are in Nebraska we can show you a good time. If there is anything that the Governor’s office can do in the way of supplying information for this convention, or assisting in any other way by showing you a courtesy, you have only to call on me.

Thank you very much. [Applause]
Governor Crosby and Members of the United States Livestock Sanitary association, Ladies and Distinguished Guests:

It is indeed an honor and a privilege to respond to Governor Crosby's remarks. When I listened to him extol the virtues of the Great State of Nebraska, after having listened to Mr. Fogarty yesterday, I wondered whether we are actually in Nebraska or possibly down in Texas. [Laughter]

I don't believe I have attended a meeting of sanitary officials in a good many years at which we felt so completely at home and at ease as we feel here in Omaha. It seems as though they have the facilities and other things that meet with our approval.

Governor Crosby mentioned the fact that Nebraska is tipped. I don't know exactly what he meant by that, but I wonder if that tipped condition may have had some effect on a few individuals I have noticed around about. [Laughter]

Indeed it is a pleasure to be here. The cordiality and the hospitality extended to us by the people of Omaha and Nebraska could not be better. We had a wonderful dinner at the Yards the other day, as the guests of Mr. Coffey, and it was unsurpassed.

The thing that astounded me was the number of animals in that Yard, both cattle and swine. While I have been through Omaha, this is the first time I have ever really stopped off here, and after visiting those Yards I can see that this could easily be the greatest cattle market and the greatest livestock market on the face of the earth. That is really something to brag about.

I can see why everybody is so happy and prosperous. You are really living off the fat of the land, and you really brought out something, Governor, which is true, which I don't think is fully appreciated, and that is the fact that the prosperity of this nation depends almost entirely upon the prosperity of the livestock industry—and its prosperity to a great extent depends upon the health of its animals.

We are really proud of our accomplishments. We are confident that with the support we are getting from our livestock people we will be able to maintain a healthy livestock, and that this country to a large extent will survive and will be a prosperous nation and will continue to be a great nation because of the health of its livestock and the value that it contributes to the nation.
Good morning, ladies and gentlemen. On behalf of the Omaha Chamber of Commerce it is my very great pleasure to extend to you a cordial welcome to this city in which you are holding your 1954 convention.

I am not going to labor that welcome because I know you know you are very welcome. If you are like me, you sometimes wonder what makes a city tick, and in the two or three minutes I have at my disposal I would rather devote my time to a few facts about Omaha than repeat that you are welcome.

We do want to thank you for coming here this year, because it is especially valuable to Omaha. As you all so well know, we are located in the heart of the important livestock growing and feeding area. You well know too that Omaha is one of the leading livestock markets in the country, and so it is particularly fortunate for us that you who are experts in your line are meeting in our community for the discussion of problems that are so vital to us.

That is the first thing I always like to tell anybody who asks me about what makes Omaha tick. I tell them that Omaha, located as it is in a farming and livestock area, is one of the world’s leading livestock markets and meat processing centers. I think that is probably the most important single fact of our economy here in Omaha.

The geographical location in the farm belt is one thing. The second thing that has helped to make our market is the fact that our transportation facilities here have been so good, both by truck and by rail. You know, for instance, that Omaha is the headquarters of the Union Pacific Railroad system. Perhaps you also know that we are the western division headquarters of the Burlington. Perhaps you know that eight other railroads serve this community, making it the fourth rail center of the country.

You have heard of Ak-Sar-Ben. Ak-Sar-Ben is the unique civic institution here that devotes a great deal of time and attention to the livestock industry. Ak-Sar-Ben, for the benefit of those of you who come from a distance, is “Nebraska” spelled backward. It is a civic organization that has existed in this community for more than fifty years. It has 20,000 dues-paying members, so you can see that it really reaches down into the roots of our community.

It has a very extensive program, free outdoor shows for the members in the summertime, an annual coronation ball, and an annual livestock show and rodeo, annual horse racing, and many other things. Perhaps as you drive around you will see Ak-Sar-Ben’s multi-million dollar plant, which includes one of the finest race tracks and one of the finest coliseums and some of the finest livestock barns in the country.

I am sure everyone in this room—in fact, most people in the world—have heard of Boys Town. Father Flanagan’s Boys Town, incorporated as an independent village, is located just eleven miles west of where you are sitting, on a fine four-lane paved highway. If you have time you should see it. It is a beautiful campus, it is a unique institution, it is an organization that is doing a great deal of good for home-
less boys and waifs from all over the country, and you will all enjoy a visit to Boys Town.

This is our centennial year. Omaha was started in 1854. That is not very long ago to some of you people from older sections of the country, but we are proud both of our youth and of our 100 years—proud that we have been able to accomplish so much in such a relatively short period of time.

Most of the centennial attractions are over. We had the usual parades and pageants and things of that kind, but I can assure you that the centennial spirit of hospitality lingers on, and that you will have something of the savor of it while you are here.

I could go on like this indefinitely, but it would be an imposition on your time because, after all, I see how crowded your program is, full of scientific discussions, and I don't want to take any time from that.

I do want to leave you with this thought: We are sandwiched in between two of the finest and most colorful and most beautiful convention cities in America—Atlantic City and New Orleans. We can't give you anything like the Boardwalk or the French Quarter or the Atlantic Ocean or the Gulf of Mexico, but we of the Chamber of Commerce and we of Ak-Sar-Ben and we of the livestock market here are interested that you go home and tell your friends that you have just visited one of the friendliest cities in America, because I think that is what you will find we are.

Thank you once again for the compliments you have paid us in visiting in our midst. [Applause]
RESPONSE

DR. RALPH WEST

Mr. Fogarty, President Green and Members of the Association:
I was rather dismayed a few minutes ago, as well as highly complimented, when Dr. Green requested me to respond to this very splendid address of welcome by Mr. Fogarty—dismayed because I realize my limitations as a public speaker, and complimented to think that President Green would think I have the ability to represent this Association in making this response.

I hope we will not end up in quite the same position as the carpenter, the employee and the foreman on the housing project in Minneapolis. The foreman was watching a man work, and every few minutes he would start nailing siding on the building. He would take a nail out of his apron, look at it, throw it over his shoulder, take out another nail, and drive it in. He kept throwing away every other nail or so. Finally the foreman walked up to him and said, “What’s going on here? Don’t you know those nails cost money?”

“Look at the darned thing,” the worker said. “Half of ’em have the head on the wrong end!!” [Laughter]

The foreman said, “You dumb cluck, can’t you save ’em and use ’em on the other side of the building?” [Laughter]

Perhaps Dr. Green and I will both be in the same boat, I as the carpenter and Dr. Green as the foreman, asking one of his employees to make this response.

Mr. Fogarty, the livestock sanitarians don’t have very much opportunity to blow their own horn, and usually a response to an address of welcome is the time we take advantage of our opportunity. I realize time is very precious, but I do want to say that you people know what the livestock industry means perhaps more than almost any other city in the nation.

I don’t believe many livestock growers, many people engaged in the industry, realize quite in what tremendous jeopardy our great economy would be if we did not control the diseases of livestock. The entire livestock economy, as well as the economy of the nation, depends upon disease control, and this Association is certainly instrumental, probably more so than any other organization in the world, for the control of livestock diseases.

As I said a moment ago, and as we have been reminded by President Green, our time is very short, and I wish to thank you very much for your very cordial welcome.

MR. FOGARTY: May I say one more word, Dr. Green? In business life I happen to be connected with the local radio and television station. We have two full-time farm directors. I notice one of them in the room this morning.

I am sure the Omaha newspapers, the Omaha market paper and all the Omaha radio and television stations will help all of you to do what you call “blow your own horn” because we appreciate the importance of what you are doing. [Applause]
PRESIDENT'S ADDRESS

T. C. GREEN

Members of the Association and Guests:

When you elevated me to the Presidency of this Association for the current year at the meeting in Atlantic City, you conferred upon me one of the greatest honors of my career and one which I had never hoped to achieve. In accepting this honor, I did so humbly and gratefully, realizing fully the great responsibility I was assuming.

Coming from a state regarded as one of the greatest industrial states with its coal mines, oil and gas wells, chemical plants, steel mills, and numerous other industrial activities, West Virginia, the Mountain State, is not regarded by some as an important state from the standpoint of Agriculture, despite the fact we produce some of the best beef cattle east of the Mississippi River. Therefore, in selecting me as your president, I feel that you have paid compliment to West Virginia and to our State Department of Agriculture for which I again express my gratitude.

In reviewing the records of approximately fifty years ago of this Association which during its first ten years was called the Interstate Association of Livestock Sanitary Boards, I observe that veterinarians and livestock producers recognized the problems of animal disease control as they then existed and that they accepted the challenge with a determination to do something about it. I think we should pause at this point to pay respect to those eminent men whose names are recorded, who without doubt were responsible for great achievements in animal disease control and finally the organization of this Association.

Even though time has brought about many changes in the livestock industry during the last half century which scientists and regulatory officials have had to cope with, I sometimes wonder if we should not go back and study the philosophy of some of those great men of the earlier days to whom we are so greatly indebted.

Many devastating diseases of livestock have been completely eradicated or brought under control during the past fifty years for which we are justly proud, however, to the contrary, we are constantly being confronted with new disease entities which present new and serious problems to already overburdened research workers and regulatory officials. Obviously, when new diseases of which we know little make their appearance in this country, we are forced to tolerate them until through experience and research, scientific control measures become available. The point I wish to make is this—while we are waiting for information to cope with the new diseases, are we exercising fully the knowledge we have toward eradicating those diseases which we know can be eradicated with the knowledge and weapons we have at hand? Or, have we become a weak, complacent trembling group of individuals, governed by political influence and pressure groups whose desire to sell and transport disease exposed animals interstate overshadows any desire on their part to control disease, regardless of the serious consequences such transportation may have upon the recipient and his community.

In this connection, I refer particularly to our brucellosis control program and
especially proposed minimum requirements governing interstate movement of cattle. I fully realize there are those present and those who may read my speech who do not agree with me and also that this is a subject to be handled by our Committees on Brucellosis, Tuberculosis, and Regulations, however, I am taking advantage of my privilege at this time to recommend that the various committee members give serious consideration to the subject of minimum health requirements governing the interstate movement of cattle. It is not my desire to set up unnecessary trade barriers but regulations should be sufficient to offer reasonable assurance that all livestock moved interstate for feeding and breeding purposes is not affected with a communicable disease nor has it been exposed to a communicable disease. I trust these few remarks on this particular subject will not leave the impression that I have lost faith and confidence in this Association or any individual members—quite to the contrary, this Association working hand in glove with the United States Bureau of Animal Industry, now the United States Agricultural Research Service, for more than fifty years has great accomplishments to its credit. It has served as a clearing house where problems presented by diseases of livestock could be freely discussed in a democratic manner with the view of eradication or satisfactory means of control.

History records many outstanding accomplishments resulting from the deliberations of this Association, its committees, and the valuable papers presented at each session. Our Association which is unequalled, may well share with pride its part in the sound livestock economy of our country insofar as animal disease, milk, and meat hygiene are concerned. Its accomplishments, however, increase its responsibilities especially during times such as these when we are living under a constant threat of war. Our livestock is one of our greatest civil defense weapons and we are challenged both collectively and individually to keep it healthy. The continued effectiveness of this Association in animal disease control depends largely upon the manner in which it meets and solves the problems confronting it from year to year.

There are many weapons which may be employed in combating disease of animals of which no single weapon will do the job by itself. One of the most important and most effective weapons is our individual state sanitary laws and regulations. For many years, there has been a demand for uniform regulations governing the interstate movement of cattle. Some progress has been made in this direction but unfortunately the matter of adopting uniform regulations is not a simple one particularly with respect to brucellosis.

The cattle industry in the United States is divided into several categories. Some areas are devoted primarily to the production of purebred beef cattle, others to commercial beef cattle, while others are devoted mainly to dairy cattle. Some states are devoted to exporting cattle, while others are importing cattle.

There is also a gross lack of uniformity among the states with respect to brucellosis control. Apparently, there are about as many different policies governing brucellosis control as there are states. It is hoped and believed, however, that all roads will ultimately lead to the same destination namely, "Brucellosis Eradication." The difference is that some roads are much longer than others and apparently some roads have detours leading back in the direction of the point of beginning.
Therefore, it appears that until such time uniform methods of controlling brucellosis are adopted and enforced by all states under the direction and supervision of the United States Agricultural Research Service, uniform regulations setting up minimum health requirements governing interstate movement of cattle regardless of how well founded the intentions might be, would have a tendency to accelerate the spread of brucellosis rather than retard it.

I shall not attempt to cover and discuss all disease control problems which constantly confront this Association. We have attempted to appoint committees who in our opinion were thoroughly qualified to discuss the subjects assigned to them and make proper recommendations to this Association and the Executive Committee, however, I desire to call to your attention those diseases which in my opinion are of major importance.

**Tuberculosis**

I shall not attempt to review the tuberculosis control program which has been carried on for the past forty years or more, since this group is familiar with it and many of you had an active part in conducting the program. I would like to say, however, that the reduction of the disease to a minimum was a great achievement. Despite the tremendous amount of work and the large expenditure of public funds, the work was justified by the results obtained. However, there are occasions when apparent success results in failure in the end.

We know that bovine tuberculosis was not entirely eliminated but the very fact that the disease was reduced to a minimum some twenty years ago has caused regulatory officials, veterinarians, veterinary colleges and cattle producers to assume a complacent, careless attitude toward being constantly on the alert for the appearance of the disease where it is least expected.

My personal observation indicates the disease is on the increase and, therefore, to assume that on the basis of spot testing it has been eradicated or at least reduced to a point that it is no longer a major disease problem, may be a false assumption.

Most dairy and important beef herds are tested annually; also herds in this category are for the most part included when spot testing for area reaccreditation. This leaves many less important herds which have not been tuberculin tested since the areas were originally accredited. Here again, to assume that no tuberculosis exists among such herds on the basis that the more important herds are tuberculosis free, can easily be a false assumption.

Practicing veterinarians are largely depended upon to tuberculin test cattle in their respective practice areas. Many of these are young practitioners who, through no fault of theirs, have had little if any experience with bovine tuberculosis. They assume that their tuberculin testing is a mere formality for the purpose of complying with regulations rather than trying to locate animals affected with the disease which assumption leads to carelessness with respect to injections and more particularly with respect to their observations.

Veterinary colleges and regulatory officials should share equally their responsibility for the complacent attitude toward tuberculosis control assumed by many veterinary practitioners. The approved technique employed in tuberculin testing cattle has been so grossly abused during recent years, it is doubtful that we can de-
termine from our office records where we stand with respect to the incidence of this disease. It would be interesting to know by states how many cattle of the thousands tested annually for interstate movement are withheld from shipment because of tuberculosis. We know from experience that slaughter cattle afflicted with tuberculosis are being shipped to our abattoirs and even though the percentage may be small, it stands to reason that the same percentage would prevail in dairy and breeding cattle when tested on the farms. I have no statistics on which to base these statements other than my own personal observations as State Veterinarian in West Virginia.

In our state, cattle are tuberculin tested for purebred and commercial sales, fairs, interstate movement, and herd reaccreditation by practicing veterinarians at the expense of the herd owner. During my fifteen years of experience as State Veterinarian, only two animals originating from one herd have been withheld from shipment because of tuberculosis. The question in my mind is this, if inspectors at slaughtering establishments can find on autopsy a given percentage of infection, why should we not expect our veterinarians to find a comparable percentage when testing cattle for interstate movement, etc. This, in my opinion, is a subject our Committee on Tuberculosis should give serious consideration. If statistics are not available to compare the percentage of infection resulting from routine testing for commercial purposes with that resulting from the post mortem findings reported on T. E. Form 35, I recommend that our incoming Committee on Tuberculosis make an effort to obtain this information and have it available for our next session.

Before leaving the subject of tuberculosis, I wish to remind you that during the past fiscal year, 10,886 reactors were located, of which number 1,613 reactors were disclosed as a result of testing herds following the tracing of animals that showed lesions of tuberculosis on regular kill. This represents 14.8 per cent of the total reactors found during the year. During this period 552 T. E. 35's were completed while 99 or 17.9 per cent were not completed. If the 99 reports had been completed, the yield, figuring it percentage wise, would have been 1902 reactors instead of 1613. In other words, it is reasonable to assume that 289 reactors are out there somewhere exposing additional cattle.

This leads to the question, what can be done to facilitate the work being done by the Meat Inspection Division of the Agricultural Research Service which will enable the states to trace all animals reported on T. E. 35 back to the herd of origin? I trust our Committee on Tuberculosis will give this phase of tuberculosis control its careful consideration.

BRUCELLOSIS

The brucellosis eradication program has just passed its twentieth milestone and it is doubtful that any disease of livestock has brought about more discussion relative to the proper methods of control and eradication. From the country cross roads to the convention halls in the large cities where farmers, livestock dealers, community clubs, public health sanitarians, veterinarians, regulatory officials and even those on the sidelines who apparently would have no interest, comes the echo reverberating from hilltop to hilltop, personal opinions as to how the disease should be controlled, all of which have had part in retarding the progress of brucellosis
eradication. Despite the many obstructions, there are those among livestock breeders and regulatory officials who have stuck to their guns with a determination to accomplish their goal through knowledge based on scientific facts.

At the beginning of our program in 1934, only one weapon of defense was available, namely, test and slaughter reactors. During the early days, little attention was paid to interstate movement of cattle, or the concentration of cattle at exhibition centers and public sale barns. Known reactors were permitted to move interstate and intrastate through sale barns and concentration centers with little or no restrictions. Herd owners when making additions to their herds willingly accepted such cattle with an individual negative test with no knowledge of the brucellosis status of the herd of origin. Dealers peddled cows from state to state and from farm to farm where they always found gullible farmers ready to purchase such animals with no thought of health conditions not visible to the eye.

Through the aid of scientific contributions, the most important which are Strain 19 Brucella Abortus Vaccine, the A. B. R. or milk ring test, and the work accomplished by this Association, the various states and the Agricultural Research Service of the United States Department of Agriculture, many objectionable features which retarded the progress of brucellosis control have been partially eliminated which is encouraging, yet, there remains much to be accomplished. It is my personal opinion that we are right now approaching the threshold of the greatest opportunity yet to accomplish our goal. The public in general is becoming more brucellosis conscious both from the standpoint of livestock economy and public health than ever before in the history of the control program. As a matter of fact, the demand for testing cattle and vaccinating calves in some areas exceeds the ability of State and Federal agencies to perform, due to insufficient funds and available veterinary personnel.

As this is being written, the prayers of many of us appear to have been answered in the Agricultural Research Service's Proposed Accelerated Brucellosis control program with which you are acquainted. Using a familiar expression, "this is the day of decision", opportunity to eradicate brucellosis is knocking at our doors.

Calf vaccination in conjunction with other approved sanitary requirements has proven of value far beyond expectations. I am convinced that much more could be accomplished if compulsory vaccination of all calves retained on farms for breeding and dairy purposes were enforced. Vaccination of calves at the option of herd owners fails to produce a sufficient number of calves vaccinated annually to establish a noticeable resistance to the disease from a community or county level. The spread is too thin when applied to a given area where optional vaccination is the policy. Far too many herd owners who have not experienced brucellosis infection in their herds are reluctant to start a calf vaccination program until after disaster strikes them. Those herd owners with brucellosis free herds who do employ calf vaccination do so because their surplus cattle will sell to a better advantage rather than for the protection they are offering their own herds. In this connection, I might suggest that more intensified education with respect to vaccinating calves in clean herds may be indicated.

Despite the encouraging aspects of brucellosis control, we have many things to overcome which serve to retard progress. Our failure to control the sale, distribu-
tion and administration of Brucellosis Vaccine has greatly retarded brucellosis control and in many instances in those states paying indemnity, has caused the payment of indemnity on cheap cows reacting to the test as a result of unofficial vaccination. In view of the approaching accelerated program and the price now being paid for common cattle, I predict there will be a lot of sick cows unless some means is found at once to keep the administration of brucella vaccine under official control.

Resolutions were offered and adopted by this Association at our last Session in Atlantic City recommending to the Secretary of Agriculture that he issue a directive placing brucella vaccine and brucella antigen under official control. Our Secretary has called this matter to the attention of the Secretary of Agriculture requesting him to take the necessary action to comply with the context of our resolutions and recommendations, but to this time, I have received no information indicating any action whatever has been taken. It is my recommendation that this Association during the current Session take more vigorous action to accomplish this objective and if necessary as a last resort, appeal through proper channels to our respective Congressmen.

The employment of Brucella Antigen by veterinary practitioners in conducting informative tests at the request of herd owners contributes as much or more than any other single item toward the spread of brucellosis. It not only gives the herd owner an opportunity to place his reactor and suspicious cattle in the herds of cattle dealers and cow peddlers, it gives him an opportunity to screen his herd of such animals just prior to his annual official test causing false herd health records to be set up in state offices. This Association should recognize this evil practice and take the necessary action to bring it to an end even to the extent of recommending the revocation of a veterinarian's license and accreditation, if found guilty of lending his services in this direction.

VESICULAR EXANTHEMA

I shall not go into the history of the Vesicular Exanthema outbreak of 1952 and 1953 for it is a familiar subject to my listeners, however, I cannot pass up this opportunity to commend the United States Department of Agriculture Research Service for their splendid work accomplished in bringing this disease under control in so short a time. I also wish to commend the sanitary officials of each state for their efforts and success in securing the passage of legislation prohibiting the feeding of raw garbage to swine, and the establishment of quarantines when necessary to prohibit the movement of swine being fed raw garbage. I feel that it was only through the splendid cooperation of one state with the other and the combined cooperation of both State and Federal agencies that our accomplishments thus far have been so favorable.

PUBLIC LIVESTOCK MARKET SANITATION

Public livestock markets, when properly operated under strict sanitary supervision, are an asset to any community and will, no doubt, be the means of farm to market movement of livestock for many years to come. Many such markets in operation today were started on an experimental basis with a minimum expenditure
PRESIDENT'S ADDRESS

for housing facilities and necessary equipment for market operation. In most instances, those markets have made financial progress but are content to continue operating with obsolete equipment which is conducive to unsanitary conditions.

In a majority of instances, the operators of community sales are not in sympathy with the enforcement of sanitary requirements especially when such requirements involve the markets financially either directly or indirectly. I could make a speech on this subject but must move on to another phase of livestock marketing through public markets. We have regulations governing interstate movement of livestock from farm to farm which for the most part are observed and enforced. These regulations constitute one of our best weapons against the spread of disease from state to state and farm to farm.

Many livestock markets are located on state borders making them easily accessible to livestock dealers and farmers not only in the state in which they are located but the adjoining state as well. Under these conditions, livestock which does not qualify to the minimum health requirements of any state, moves freely interstate from farm to market and from market to farm.

Despite the fact that veterinary inspection is maintained at most markets, such movement of livestock without enforcement of adequate sanitary requirements, constitutes one of our greatest avenues of the spread of livestock diseases. In addition to this, those who move livestock interstate from farm to farm in an orderly manner in compliance with all health requirements, at their inconvenience and expense, fully realize that another group of livestock people are moving their livestock freely from state to state by way of a livestock market. This places the State's regulatory officials in an embarrassing position when it is called to their attention by those who move their livestock in an orderly manner. I do not pretend to know the answer to this problem but I do believe it is one this Association should give serious consideration. It may be a problem that should be considered from a national rather than a state level since it involves interstate movement of livestock for feeding and breeding purposes.

In conclusion, I wish to first pay my respect to the individual personnel of the United States Agricultural Research Services who in addition to their valuable contributions to this Association have contributed much to each state. During my career as State Veterinarian of West Virginia, it has been my privilege to come in personal contact with many officials of the Agricultural Research Services and I have always found them willing to listen to my problems and offer all assistance possible.

Finally, I express my sincere thanks and appreciation to each speaker who will appear on this program, the various committees who have been assigned the tedious task of studying our livestock disease problems for the purpose of making their recommendations to this Association. I also extend my respects and appreciation to our Secretary-Treasurer, Dr. Ralph Hendershott, of whom it might be said, a job well done.

Thank you.
PRESENTATION OF ASSOCIATION'S KEY TO RETIRING PRESIDENT
T. C. GREEN

RALPH HENDERSHOTT

Trenton, New Jersey

DR. HENDERSHOTT: Gentlemen of the United States Livestock Sanitary Association, it is time once again to take care of a very pleasant assignment as far as I am concerned. Generally at this time during the meeting we have the privilege and honor of presenting to our retiring President a slight memento of our appreciation of the many hours of hard work he has put in, and the endurance of the man in working with the other officers during the year for the benefit of the Association at large.

The memento in no way can measure up to our esteem for the work of our Past Presidents. Last year we presented to Dr. T. Childs, our retiring President, the key to the city of Atlantic City. We also presented to him a small token of our appreciation in a key that is cast for the Association.

I was not quite certain which he prized more highly. The key to the city of Atlantic City was about a foot long. That being the case, this year I thought we should present to our retiring President something that he would always cherish, and the best thing I knew of was the key to my room. [Laughter]

It is a pleasure for me, Doctor Green, to present to you this key to room 817 of the Hotel Fontenelle as a memento of your service as President of the Association. I think the room is empty—at least I hope it is. [Laughter]

Also, here is something for your own. This is the key of the Association. It has been a pleasure to work with you, Doctor Green. It has been a pleasure to serve with you, and I am sure everyone in the Association appreciates the effort you have put into the work this year. We hope you will cherish this key as a symbol of our appreciation of your efforts. [Applause]

PRESIDENT GREEN: Thank you very much, Doctor Hendershott. I prize this token very highly. I shall always keep it in remembrance and fond recollections of my association with this fine organization, which, incidentally, has been over a period of sixteen years.

I am looking forward to meeting you from year to year rather as a person who looks forward to meeting some of his dear relatives. To me there is something fine in meeting with this fine group of people, and since within a few minutes I will vacate this chair to my worthy successor, I want to take this opportunity, first, to thank our various committees that have worked so hard, without whom this meeting could not have been a success.

I also wish to thank those of you who have spent many hours preparing valuable papers which you have presented here, and all others who have helped to make this one of the best meetings this Association has ever had. I heard that echoed in the halls, and I have yet to hear the first whisper of discord. Thank you again. [Applause]
During the year we have been active in presenting to the Secretary of Agriculture our views and needs in the field of animal disease research as well as in the field of disease control and eradication.

The present administration started out with a policy of expanding research in Agriculture at federal level and reducing federal expenditures in the field of control and eradication.

Our first introduction to this change in policy was obtained in Secretary E. T. Benson's talk to the Commissioners, Directors and Secretaries of Agriculture at their Annual meeting in Niagara Falls, New York in September, 1953. However, the full impact of his remarks did not strike home until we saw the Agricultural Budget being considered in Congress earlier this year.

It seemed to us incongruous that government should spend so much time, effort and money on research and then fail to provide its share for the practical application of the result of research in the field.

When Secretary Benson failed to request funds for the payment of indemnity for brucellosis, tuberculosis and paratuberculosis, the situation was presented to the states in a letter from your secretary. The problem was discussed by phone with President Green and a meeting of the Executive Committee called for March 31st, in Chicago. The consensus of opinion of the meeting was that the secretary should direct a communication to the Chairman of the Subcommittee on Agricultural Appropriations requesting his committee include in the appropriation bill the sum of $1,500,000.00, for indemnity for tuberculosis and brucellosis; in accord with these instructions the following telegram was sent:

"Honorable Milton Young, Chairman
Sub-committee on Agricultural Appropriations
Washington, D. C.

Dear Sir:—

"I understand your committee has under consideration appropriations for Agriculture. As Secretary of the United States Livestock Sanitary Association representing all state veterinarians of the United States and many livestock producers, I would like to draw to your attention that indemnity to farmers for loss of reactors to tuberculosis, paratuberculosis and brucellosis is not included in the Department of Agriculture request. For years the Federal Government has co-operated with the 48 states in the control and eradication of these animal to man transmissible diseases of cattle and great progress has been made throughout the nation. We in this nation lead all other countries in animal disease eradication however, the work is not completed.

"Both the federal and state governments have invested millions of dollars in the advance made thus far. Across the nation because of the educational effort made, the farm people are at the threshold of complete eradication of brucellosis. It is
inadvisable at this time when states, municipalities and milk distributors are demanding complete eradication of brucellosis to withdraw federal assistance in the nature of indemnities.

"While we favor economies in government it seems illogical to attain them at the cost of losing the millions of dollars already invested in these control programs.

"It is well enough to increase our interest in research programs—much research has been done on brucellosis and tuberculosis—and I submit to you, to what avail if we do not support the application of research information practically in the field?

"Rather than delete indemnity payments at this time, we would submit to you that they be increased so that our farmers can accelerate the eradication of these diseases and thereby insure the American public a wholesome, healthful meat and milk supply.

"It would seem that the sum of $1,500,000.00, should be earmarked for the purpose of federal government payment which, incidentally, is only a fraction of the amount being expended for this purpose by the states.

"This matter is considered of such importance to us that all state veterinarians met in Chicago on March 30th, to study and make recommendations with respect to it.

"Trusting your sub-committee will see fit to add the sum requested for federal indemnity for animal tuberculosis, paratuberculosis and brucellosis, I remain,

Sincerely,

R. A. HENDERSHOTT, Secretary
United States Livestock Sanitary Association."

All those attending the meeting in Chicago on March 30, 31, 1954, were requested to contact their representatives in Congress and solicit their aid in obtaining an adequate appropriation to enable us to carry on, not only the regular progress of eradication but to enable the states to markedly accelerate the eradication program to meet the demands of public health officials throughout the nation.

I might say that as a result of our effort at that meeting, and following it the Congress of the United States not only put back the money that had been deleted from the appropriations for the Agricultural Research Service, but through their action they have given the Secretary of Agriculture the right to take out of the Commodity Credit Corporation the sum of $15,000,000.00, for the current fiscal year and for the next fiscal year, to advance and to accelerate the program for the eradication of brucellosis.

I have only one comment to make in respect to it, and that is that the allocation of these funds to the federal disease control officials, to be expended in our states, certainly places a great responsibility on the shoulders of not only those in the Agricultural Research Service, but certainly on the shoulders of the state regulatory officials, and it would be rather a sad situation if at the end of two years, we had not very materially reduced the incidence of brucellosis in our livestock population.

I think all of us in our states should set our program with the goal of at least bringing brucellosis into the same status that we currently enjoy with respect to tuberculosis by the time this $30,000,000.00, is expended.

On March 31st, 1954, a meeting was called of the sub-committee on the "Pilot Test Area for the Eradication of Hog Cholera." Doctor C. L. Campbell of Florida
served as chairman and attending were several state veterinarians along with members of the biologic production industry and representatives from the Agricultural Research Division of the United States Department of Agriculture. A full day was devoted to the discussion of the Pilot Test Area and your Secretary was requested to discuss with the officials in Washington the possibility of federal participation in the field research project of hog cholera eradication, to the extent of matching funds being expended by the State of Florida amounting to $117,000.00.

It was pointed out that contrary to the opinion of some that even if successful in obtaining federal assistance no money could possibly be available July 1, 1954, because federal budgets were made up at least one and a half years before the date of availability.

The question of federal participation was discussed with officials in Washington on April 1st, with the result that I am confident a request for about $100,000.00, may be included in their asking for the fiscal year starting July 1, 1955.

We undoubtedly will need some assistance from all of you folks in presenting to Congress the need for sufficient funds to permit the federal government to assist in this most worthy endeavor.

This, incidentally, is one of my pet projects and I firmly believe that all effort should now be directed to the nationwide eradication of hog cholera. I am confident we have the tools at hand to accomplish the task and that the “Pilot Test Area” will provide us with an actual demonstration of the proper approach to this problem.

A lot of educational work will be required to lay the groundwork for eradication, and must be done in order to insure the whole-hearted cooperation of the swine industry without which no progress can be made.

The universal cooking of garbage fed to swine, plus the discontinuance of license to produce virulent virus vaccine, could well be the initial steps that would lead us to victory over this costly disease that levies an unseen tax on every pound of pork and pork products the consumer buys. Why we continue to live with this eradicable disease in the light of the example provided by our good neighbor Canada is beyond all reason.

SCRAPIE

On May 11, at the invitation of Dr. R. P. Anderson, I attended a meeting in Washington D. C., called to discuss the present situation throughout the nation with regard to scapie and the progress that is being made to eradicate the disease. At this meeting there were many members of the Agricultural Research Service, as well as B. T. Simms, who is in charge of the Animal and Parasite Research Branch, representatives from Canada, representatives from the Sheep Breeders Association, representatives from A.F.B.F., A.V.M.A., The Agricultural Press and the state veterinarians from Ohio, Indiana, Connecticut, California and New York.

The group was addressed by Dr. M. R. Clarkson, who stated the reason for the meeting, and informed us that some ten days ago a meeting was held in Washington to which was invited the research workers of the United States who have been working on scapie.

Dr. C. D. Houweling, Director of Livestock Regulatory Programs, was chairman of the meeting. He called upon Dr. R. J. Anderson, Chief of the Animal Disease
Eradication Branch, to briefly review the history of scrapie in the United States. Dr. Anderson brought out that the first recorded case of scrapie in the United States was in 1947 in Michigan, and that this fact did not come to light until California reported the outbreak of scrapie in sheep in that state in 1952. Subsequent to the 56th Annual Meeting of the United States Livestock Sanitary Association and as a result of the showing of a film on scrapie by Dr. Boyd of California, Dr. Hay thought that they had scrapie in several flocks in Ohio. This he confirmed on his return home. Since that time a suspected case has been reported from Indiana, a definite case in the State of Connecticut, two flocks in New York State and also in Illinois.

At the Louisville meeting, at the direction of the Executive Committee of this Association a telegram was sent to the then Secretary of Agriculture Brannon requesting that he declare scrapie an emergency condition which would permit the Federal Government to participate in the eradication of the disease with personnel and the payment of costs in cooperation with the state. On October 31st, Secretary Brannon declared scrapie an emergency. At that time it was our understanding that scrapie was confined to the State of California.

The infected flocks in California were promptly destroyed, as were contact flocks, and indemnity paid for the full market value of the animals destroyed. California had 53 premises under quarantine as a result of scrapie and two farms on which the infection was definitely diagnosed. Both of the infected farms failed to restock following the slaughter and burial of the infected and exposed animals. In the 51 contact flocks, which were contact because of the presence of animals from one or the other of the two infected premises, the animals introduced from the infected premises and their offspring were slaughtered. Of the offspring from the 51 exposed flocks in the neighborhood, 21,000 lambs have now gone through slaughter leaving only 49 lambs to be slaughtered and at the present time leaving but four contact farms under "Hold" orders, comparable to quarantine. Both the Federal and State Government paid in the neighborhood of $16,000 indemnity and the State of California now has appropriated $23,600 which will be employed as additional compensation to those owners whose animals were destroyed.

In Indiana there is one suspected flock resulting from the presence and introduction of animals from the infected flock. The added animals in question were slaughtered and the flock remains under surveillance and periodic inspection.

Ohio reported the disease in five flocks, three of which were purebred breeders and two commercial flocks. One of the purebred breeders converted his operation to a commercial flock operation. The two remaining purebred flocks have gone out of sheep production. While all of the flocks involved were Suffolk, there is a question about the possibility of some Cheviot sheep having been involved earlier in Ohio. The Ohio approach to the problem of scrapie was to call meetings of the sheep breeders and to brief them on the disease and seek their advice about the method of handling. As of May 11, 1954 there still remained in Ohio three flocks which are under Federal quarantine. These have since been liquidated.

In New York State two flocks were found infected. One flock of 25 purebred Suffolk lost four with the disease. The flock was placed under quarantine and it is expected that the entire flock will be sold for slaughter. The second flock, which obtained a ram from the original flock, is under quarantine and New York is interested
in learning what procedure would be recommended. At the present time I understand all infected flocks have been slaughtered.

Dr. Jean Smith of Connecticut reported the infection in one flock. The history showed that some 20 imported Suffolk breeding animals introduced the disease. No indemnity was available for reimbursement of this owner, and he still has the flock intact under state quarantine and there seems to be some question whether or not, with only one flock involved and with such a low sheep population in the state, whether support could be engendered in the legislature to provide indemnity for the disposal of this flock.

Dr. Orlan Hall reported that the initial case on record in Canada was in 1938, but that little was done about the disease at that time. The current method of handling the situation is to destroy the infected flock and to pay the owner the replacement value for the animals destroyed. They are also tracing back through the sales records the disposition of breeding animals from the flock during the three years prior to the establishment of a positive diagnosis. They do not slaughter the contact animals which have been sold into other flocks. They instruct the owners of the long incubation period associated with the disease and continue surveillance of the flocks for three years, demanding that the owner keep a record of all sales and that he report any suspicious cases as soon as they may occur. To date they have not found any evidence of scrapie in the contact flocks except in one instance. The contact flocks are not under quarantine, but close check is kept on them. They have about 100 contact flocks, which are being inspected semi-annually.

Mr. Petersen, who accompanied Dr. Orlan Hall, indicated that they have no difficulty in tracing all of the sales from sheep flocks. They have a National Records Association which records the transfer of all animals. He did recommend that all sheep be identified either by a tattoo or a good ear tag and records of sales or transfers be kept.

Dr. Simms was asked to talk about his knowledge of research that has been conducted with regards to scrapie and he stated that since the disease has occurred for some time in the United Kingdom, that we were dependent upon the veterinarians in research work in England to provide us with the results of their investigation. He reported a rather interesting experiment conducted in Scotland, started in the year 1932, in which they placed 25 sheep on a pasture which had previously been used by scrapie infected animals. The 25 sheep, of course, produced lambs and the first case of scrapie occurred three years and three months after the sheep had been placed on the infected pasture. Thereafter, all of the animals raised on the pasture came down in a short time until 40 per cent of the sheep revealed symptoms of scrapie. Another sidelight of the experiment was in the production of louping-ill vaccine, which is a "killed" vaccine and how in England in 1935 the British officials received reports that some sheep, treated with the louping-ill vaccine 18 months prior, had come down with scrapie. In tracing back the source of the animals used for the production of the louping-ill vaccine, it developed that some lambs were used from the experimental lot of sheep being fed on the infected pasture. The lambs used in the production of this vaccine were obtained from the lot one year prior to the appearance of the first symptoms of scrapie in the sheep on the infected pasture and the animals which were given a subcutaneous injection of the louping-ill vac-
cine did not show lesions until 18 months following vaccination. This established the fact that consideration must be given to pasture control on those farms where scrapie occurs. It also established the fact that lambs raised on the pasture from the sheep that grazed there were infected with scrapie long before symptoms were observed in animals on the infected pasture. Louping-ill vaccine is treated with 1/3 of 1 per cent formalin and vaccine prepared in the fall is not used until the next spring. Therefore, the virus of scrapie contained in the vaccine had been exposed to formalin for a period of 180 days prior to its use and still transmitted scrapie. He pointed out that in the serial transfers of virus intracerebrally resulted in the development of infection in about four to six months. Also, the injection of scrapie material into the brains of various breeds of sheep determined that there probably is no resistant breed.

Pathology—The pathology of scrapie is not particularly characteristic and the diagnosis must depend upon observation of symptoms and the histo-pathological examination of the brain tissue and the finding of vacuoles in the neurons of the brain and spinal cord. Inclusion bodies similar to negri bodies may be seen. However, similar inclusion bodies also are found in specimens from animals affected with louping-ill and rabies. Cuffing about the blood vessels is also observed in the central nervous tissue of affected animals. This alone, however, is not significant, as it occurs in other infections involving the central nervous system. They reported the history of an infected ram bred to a ewe whose lambs came down with scrapie two years later at their lambing time. Dr. R. T. Simms reported the virus resistant to drying, but susceptible to moist heat. However, there was a statement brought out at the meeting that a recent release indicated the virus resisted heating to 85°C.

One of the important points brought out at the meeting was the fact that we need more information relative to the length of time pastures may serve as a source of infection for sheep. A second point that was of importance was that all breeding sheep should be permanently identified and records kept of their sale and distribution.

Dr. C. R. Omer reported on his investigation of outbreaks of scrapie in the United States and he presented some very interesting histories relative to the transfer of animals. He also emphasized that it was important in one or two instances to carry out an extensive investigation of possible contact flocks because scrapie infected animals were not properly identified. It was pointed out that when scrapie is found it is of tremendous importance that all the sales to other flocks be traced, so that the contact flocks could be placed under surveillance. This, of course, necessitates the permanent identification of animals and an accurate record of their disposition.

PROPOSED SCRAPIE ERADICATION PROGRAM

"1. Immediate reporting of suspicious cases. Dissemination of information on scrapie to all veterinarians, extension agents, and sheep owners; also showing of scrapie picture, stressing the prompt reporting of suspicious cases to proper officials.

"2. Diagnosis of the disease. Tentative clinical diagnosis to be confirmed by State and Federal laboratories.

"3. Quarantine. Suspicious flocks should be immediately placed under state quar-
antine and augmented by Federal quarantine when laboratory finding is positive for scrapie. State and Federal quarantines to remain in effect until all infected and exposed sheep are slaughtered and the premises are cleaned and disinfected.

"4. Indemnity. Indemnities to be paid for infected and exposed animals when disposed of in accordance with State and Federal regulations.

"5. Disposal of infected and exposed animals.
A. Animals showing symptoms of scrapie to be slaughtered on the farm and buried or burned.
B. Exposed animals (including animals moved from the infected flock since apparent introduction to infection) may move for immediate slaughter under permit and supervision to an approved slaughtering plant.
C. All exposed sheep are to be moved in such a way that positive identity of all animals is maintained, and report of their slaughter is to be confirmed by the veterinary inspector in charge of slaughtering where the animals are received.
D. Cleaning and disinfection of premises and conveyances.

"6. Flock history and inspections.
A. Establishing the origin of infection in a flock and inspection of flocks from which the infection may have been introduced.
   (1) Inspect all flocks from which additions to the infected flocks have been made within three years. These inspections are to be made at six month intervals for a three year period following such movements.
B. Movements from infected flocks.
   (1) Inspect those flocks into which sheep from the infected flock have been sold within the last three years. These inspections are to be made at six month intervals for about three years following such movements.

"7. Amend the import requirements to require that all imported sheep and goats be held under surveillance on farms for a period of three years."

The afternoon was devoted to a proposed scrapie eradication program. Under point one in the discussion, it developed that there is a very good silent moving picture depicting the outbreak in California and that Dr. Frank A. Todd of the Civil Defense Administration is currently piecing together the California film and one taken elsewhere and is developing a sound movie which should be completed sometime in June for exhibition as suggested in paragraph one.

In the discussion of indemnity in paragraph four, the reports of the Sheep Breeders Association felt that the Federal Government program of payment of indemnity; namely, three times the meat value for purebred animals, would be entirely inadequate in a scrapie eradication program. They pointed out that rams and ewes used for breeding had little meat value. However, the value to the sheep breeders was considerable and that some rams were valued at $100 to $500. They felt that if we were to receive the cooperation of the sheep breeders that they should be reimbursed on the basis of the replacement value of the animals. Others expressed themselves of the opinion that in most of our indemnity programs, the farmer stood a part of the loss. Others felt that since so few flocks were involved in the country it might be smarter to pay replacement costs rather than to encourage the hiding of sus-
pected cases. It was also brought out that in the payment of indemnity for animals destroyed because of vesicular exanthema, that the full appraisement was paid jointly by the State and Federal Government; the farmer in this instance assuming no portion of the loss. The consensus of opinion was that full indemnity should be paid, such as is being done in the Dominion of Canada.

In paragraph five, which was approved as read, the discussion brought out the fact that they had failed to deal with the pasture problem. It was stated that in the research workers discussion a minimum of 90 days be suggested. Of course this, in the light of our discussion and the information presented by Dr. Simms, would lead one to the conclusion that 90 days would be of little or no value in prevention so far as exclusion of sheep from infected pastures is concerned.

Point seven, which proposes all imported sheep and goats be held under surveil- lance on farms for a period of three years, poses quite a personnel problem.

We know scrapie is a virus disease with the localization of the virus in the brain and spinal cord; that the disease may appear in the progeny of parents who may not develop symptoms of the disease until after their progeny have shown symptoms. There are some cases on record in which the parents apparently never reveal clinical symptoms of the disease. There is no information available relative to the establishment of immunity nor the possibility of vaccination. The recommended material for disinfection at the present time is:

Sodium Hydroxide (lye) NaOH—13 oz. to 5 gals. of water (2% solution).
Sodium Carbonate (soda ash) Na₂CO₃—1 lb. to 3 gals. of water (4% solution).
Sodium Carbonate (sal soda) Na₂CO₃·10H₂O—13½ oz. to 1 gal. of water (4% solution).

The meeting was an interesting one undoubtedly called to endeavor to standardize eradication procedures in the areas in which scrapie is diagnosed.

Following these meetings a letter was received from Doctor R. J. Anderson which reads:

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
ANIMAL DISEASE ERADICATION BRANCH
WASHINGTON 25, D. C.

Dr. R. A. Hendershott, Secretary
U. S. Livestock Sanitary Association
1 West State Street
Trenton 8, New Jersey

July 26, 1954

Dear Dr. Hendershott:

Following recent meetings of research workers, sheep industry representatives, a number of State livestock sanitary officials, and members of this Department to discuss a program of concerted action against scrapie, the Department promulgated
9CFR Part 54, which specifies the manner in which Federal indemnity payment may be made for sheep destroyed because of this disease.

The regulation has two principal provisions:

1. To pay owners of sheep destroyed under the program a Federal indemnity "not to exceed 50 per cent of the difference between the appraised value of each animal so destroyed and the net salvage received by the owner thereof . . . the Federal Government's share of the indemnity to be limited to $25 per head for grade animals and $75 per head for purebred animals;" and

2. To permit the Federal Government to pay its share of the indemnity to owners, whether or not the State participates in the indemnity payment.

The regulation permits appraisal of sheep on the basis of their actual value at the time and place of appraisal. Previously, appraisal of sheep was limited to meat values, or in the case of purebreds to not more than three times meat values. Payment of Federal indemnities formerly was contingent upon the State Government's participating equally in such payment.

Copies of the new regulation and of the scrapie eradication program are attached for your information.

Very truly yours,
R. J. ANDERSON
Chief of Branch

REPORT OF THE AUDITING COMMITTEE

M. N. Riemenschneider, Denver, Colorado, Chairman; R. W. Smith, Concord, New Hampshire; R. L. West, St. Paul, Minnesota

Dr. M. N. Riemenschneider: The Auditing Committee examined the records of the Secretary-Treasurer and found them to be in good order.
MEMORIAL SERVICE
RALPH L. WEST
St. Paul, Minnesota

Since we met in Atlantic City last September, the following Members of this Association have passed to the Great Beyond:

Dr. C. E. Wicktor, Chief Veterinarian for County of Los Angeles, Cal. died suddenly on Oct. 27, 1953. Dr. Wicktor was chairman of the Committee on Morbidity and Mortality and was very active in formulating an efficient and workable reporting service.

Dr. David F. Jaffray, Rockford, Illinois died November 4, 1953 at the age of 75.

Dr. F. Ray Smith, Boswell, Indiana, former State Veterinarian of Indiana, died November 10, 1953, at the age of 60 years.

Dr. David H. Ricks, Oklahoma City, Oklahoma, State Veterinarian of Oklahoma, died November 19, 1953 at the age of 52.

Dr. R. P. Marsteller, Dean Emeritus of the School of Veterinary Medicine, Texas A & M College, died January 1, 1954 at the age of 71.

Dr. Leo F. Rettger, former member, credited with much of the early research on pullorum disease, died Jan. 7, 1954, at age of 79.

Dr. Charles E. Cotton, Minneapolis, Minnesota, former State Veterinarian of Minnesota and former Secretary and Past President of this Association, died April 21, 1954 at Prescott, Wisconsin at the age of 82.

Dr. William E. Mohler of Washington, D. C., died June 9, 1954 at the age of 53. Dr. Mohler was the son of the late Dr. John R. Mohler and had accomplished much important research for the United States Bureau of Animal Industry, including the development of the complement fixation test for anaplasmosis.

Dr. Gilbert E. Botkin, Marion, Indiana, another former Indiana State Veterinarian, died June 21, 1954, at 65 years of age.

Dr. A. H. Davison of Urbana, Illinois, former County Veterinarian of Champaign County, died June 27, 1954 at 63 years of age.

Dr. Wm. Moore, Cary, North Carolina for many years, State Veterinarian of North Carolina and Past President of this Association, died July 12, 1954 at the age of 70 years.

Dr. Dennis Coughlin of Topeka, Kansas, for many years Inspector in Charge for the United States Bureau of Animal Industry in Tennessee, and at the time of his death, holding the same position in Kansas, died August 11, 1954 at 64 years of age.

Dr. Carl J. Norden, Sr., of Lincoln, Nebraska, founder and Chairman of the Board of Directors of Norden Laboratories, died August 21, 1954 at 65 years of age.

Doctor A. F. Bain, head of the Department of Bacteriology, Ontario Veterinary School died of a heart attack on August 27. He was a valued member of this Association and an able instructor.
I respectfully request that all persons present stand in silence for one minute in respect to these departed colleagues.

[Silent standing tribute to departed members]

Two of the men mentioned above were extremely active in the affairs of this Association and both served a term as president. Dr. Charles E. Cotton was born in Prescott, Wisconsin September 18, 1871, a son of a pioneer physician practicing there. He graduated from the University of Pennsylvania in veterinary medicine in 1893 and after a short term as house surgeon at his Alma Mater, established a very successful practice in Minneapolis, Minnesota.

Dr. Cotton had a unique quality of leadership. In spite of a tremendous practice, he always found time to participate actively in association and civic affairs, and from the early days of his practice, was interested in disease control. While at the University of Pennsylvania, he was present when, for the first time in the United States, the tuberculin test was applied to cattle, and in 1896, while serving part-time as City Veterinarian of Minnesota, was instrumental in the enactment of the first City Ordinance in the United States requiring the tuberculin testing of all cattle supplying milk to the city.

During his long term of service, his ability and diligence were recognized and many honors conferred upon him by the veterinary profession, the livestock industry and public health organizations. He was elected President of the Minnesota Veterinary Medical Association in 1909, President of the American Veterinary Medical Association in 1916, and was awarded the Twelfth International Veterinary Congress prize in 1952 by the American Veterinary Medical Association, and was elected to life membership in the Minnesota Public Health Association.

Dr. Cotton was a leader in the successful efforts of the livestock industry of Minnesota in obtaining enactment of the law establishing the State Live Stock Sanitary Board, and was appointed to the Board by the Governor when it was established in 1903, where he served continuously until he resigned to accept appointment as Secretary and Executive Officer of the Board (the State Veterinarian of Minnesota) in 1919.

From the time he became a member of the animal disease regulatory agency in Minnesota, he was active in the United States Livestock Sanitary Association, being a constant attendant. In 1907 he was elected Secretary and served through 1908 and 1909, the last two years that this Association was known as the Association of State Livestock Sanitary Boards. At the 1909 meeting, he was elected President of the Association and served as president during the first year the Association existed under its present name. During the succeeding years, Dr. Cotton was very active in the affairs of the Association, serving on various committees and particularly, for many years as a member and sometimes chairman of the Committee on Tuberculosis. He was also active in the organization and served as first president of the National Assembly of Chief Livestock Sanitary Officials, an organization closely related to the United States Livestock Sanitary Association.

I think of all the outstanding traits of Dr. Cotton's personality, his complete fearlessness and integrity were the most outstanding. While demanding efficiency and diligence of those serving under his direction, honest errors could be excused but he had no sympathy or patience with lack of complete honesty. Dr. Cotton
had strongly fixed opinions regarding politics, but never allowed political activities to interfere with sound disease control. His motto which he followed explicitly in his official capacity was "there can be no compromise with disease." He was a past master at detecting veiled efforts to obtain favors through amendments to regulations or exceptions thereto. Regardless of any influence, personal or political, such efforts were always promptly and emphatically denied.

My associations with Dr. Charles E. Cotton, while I served with him on committees of the State Association, as an employee under his direction, and still more closely with him on the Procurement and Assignment Committee during the Second World War, are prized more than I have the ability to express. He was a real man, a real gentleman, and a real veterinarian.

Dr. William Moore also played a prominent part in the activities of this Association and was also a leader in the control of diseases of domestic animals in this country. He served as president of this Association in 1946.

Under Dr. Moore's direction, North Carolina was the first state to be declared a Modified Accredited Tuberculosis-Free Area, and the first state to be declared a Modified Certified Brucellosis-Free Area. He was recognized as an authority on disease control procedures. In addition to the respect which he earned as a highly capable State Veterinarian, he was loved and honored by all who knew him.

This is a very inadequate testimonial to the memory of all these splendid men. Only a person with much greater oratorical ability could begin to do justice to them, but regardless of the words we use, I am sure the names and memories of these fine individuals will be cherished by all of us throughout the years, and will inspire us to greater effort to carry on the work which they have so well initiated.
HIGHLIGHTS IN THE LIVESTOCK REGULATORY PROGRAMS FOR 1954

C. D. Van Houweling, D.V.M.  

It's good to have this opportunity to discuss the highlights in the livestock regulatory programs during the past year. There have been many interesting developments—in our organization, in the legislation we enforce, and in the diseases we must fight. Some of these stories will be reported in detail by other speakers. I will comment briefly on the headliners.

The first big story of 1954 was the reorganization of the United States Department of Agriculture. This took effect on January 1 and brought several important changes.

The activities identified with the Bureau of Animal Industry for almost 70 years were placed in two administrative units—Livestock Research and Livestock Regulatory Programs. Both of these became a part of the new agricultural research service, which was formed by the merger of the Bureau of Animal Industry and several other research Bureaus of the Department formerly under Agricultural Research Administration.

One effect of the new set-up was to broaden the base of administrative responsibility. This reflects a significant change throughout the Department. It begins in the Secretary's office where each Assistant Secretary has been given a dual responsibility. He is not only a member of the staff who advises and consults with the Secretary. He also carries full responsibility for the operation of the agencies in his group. (Slide 1)

Our work is in the group concerned with Federal-State relations. In addition to the Agricultural Research Service, it includes the Forest Service, Federal Extension Service, Soil Conservation Service, and Agricultural Conservation Program Service, and the Farmer Cooperative Service.

The administration of each of these Services is set up along lines similar to that of the Secretary's office. The administrator has assistants, each of whom carries a dual responsibility. As a member of the staff it is his duty to advise on the management of the entire Service. In addition he is responsible for the operation of certain areas of work. (Slide 2)

The Agricultural Research Service—under the leadership of Dr. Byron T. Shaw—coordinates regulatory and research activities. The funds and manpower are about equally divided between the two. Dr. M. R. Clarkson, who is well known to this group, is responsible for the administration of the regulatory programs, both for livestock and crops.

The work of the Livestock Regulatory Programs, where I have the privilege of serving, is divided into three branches.

The Animal Disease Eradication Branch, under the direction of Dr. R. J. Anderson, is made up of six sections. Four of these are concerned with the eradication of specific diseases—brucellosis, tuberculosis, vesicular exanthema, and special dis-

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asures. Another section supervises the inspection of public stockyards. There is also a section for the enforcement of interstate regulations. Dr. Anderson and his group also have the responsibility—with Mexican officials—for the eradication of foot-and-mouth disease.

Dr. C. L. Gooding is Chief of Animal Inspection and Quarantine. This is the Branch that administers the laws and regulations designed to prevent the introduction of diseases which could seriously hamper our livestock and poultry industries. To carry out this responsibility, inspection service is furnished at more than 90 ports of entry where livestock, poultry, and animal products are inspected before entry is permitted. The Branch also certifies to United States Customs for purposes of free entry pure-bred animals imported by citizens of the United States for breeding purposes, administers the laws and regulations governing the inspection and certification of livestock for export to assure that only healthy animals will be received by destined countries, and has the responsibility of regulating the production and distribution of veterinary biological products through a system of licensing and inspection of establishments producing such products.

As Chief of the Meat Inspection Branch, Dr. A. R. Miller supervises operations in more than a thousand packing plants across the country. These are the plants that convert some 90 million food animals into meat and meat products. The work covers the examination of live animals as they are brought into the plant and the carcasses as they are processed for food.

As you know, it's the meat inspector's job to see that meat is derived from
healthy animals, that there is no adulteration or mislabeling, to make sure the environment is sanitary, and to supervise the processing of meat for government contracts. One of the newsworthy developments in the Branch this year was the expansion of this assignment for the Army. In July the Branch began conducting this inspection and is now doing the work in over 150 plants in 60 locations for the Army Veterinary Corps. It has taken only a small number of additional employees to integrate this inspection with work that was already in progress.

This brief outline of the organization of livestock regulatory programs gives an idea of the scope and complexity of the work. Measured in terms of the size of this job, our force is small—only 1,300 veterinarians and about 2,500 laymen.

A word on this point. We don't have enough veterinarians and we're having real difficulties in replacing those who retire or leave government to enter private practice. This is not a new development. There has been a steady decline in recent years. For instance, in October 1950 there were 1,517 veterinarians in the regulatory services of the Bureau of Animal Industry. The number had been reduced to 1,451 by the end of 1951. It was down to 1,340 at the beginning of this year. It has not been increased.

We believe our staff of veterinarians is somewhat below the minimum. It must not decline further, and if it does, we will not be able to carry out our responsibilities to the public. We don't want to build a large corps of workers in regulatory service. But the present staff must be expanded to the recommended strength. This is necessary if we are to be prepared to cope with emergencies and give continuing protection to the nation's food supply.

For many years Federal livestock regulatory workers have extended their coverage through cooperation with other agencies—particularly with the States in animal disease eradication—with other Federal agencies in animal inspection and quarantine—with the livestock, biological, and related industries—and by utilizing the services of practicing veterinarians. Cooperation of this type was used to good advantage on all fronts during the past year.

The reorganization has facilitated this cooperation. It has given broader responsibilities to the Federal veterinarian who represents the Animal Disease Eradication Branch in the State. He is now responsible not only for the tuberculosis and brucellosis eradication programs but also for the campaigns against vesicular exanthema, scabies, scrapie, bluetongue, and any other livestock diseases of concern to the State and Federal agencies. In other words, under the new set-up State officials work with one man on all of these programs and he has the responsibility for the whole program of the Animal Disease Eradication Branch in his State.

This year a new type of cooperation has been initiated in South Carolina and Wisconsin. In each of these states, one man has been placed in charge of both the State and Federal livestock regulatory programs.

A former Federal employee—Dr. Richard W. Carter—is the Director of the State-Federal Animal Disease Eradication Programs in South Carolina. And a former State man—Dr. Harry J. O'Connell—is the Chief Veterinarian of State-Federal Animal Disease Eradication Programs in Wisconsin.

The plan of having one man represent both the State and the Federal governments did not originate in the Department of Agriculture. But we are very much
interested in it. If similar arrangements appear desirable in other States, we shall
be glad to review them with proper State officials.

The reorganization is strengthening our organization and furthering cooperation
in another way by providing more area direction of the activities of the Branches.
Each Branch has established geographical areas of the United States over which a
section head or an assistant to a Chief has branchwide supervisory responsibility.
In the Animal Disease Eradication Branch this plan is being carried on down into
the States, and areas are being assigned for supervision of all Branch programs.
As these positions are filled we will be in better position to use veterinarians on a
fee basis. Experience has shown that the practicing veterinarians can be used to
good advantage in Federal regulatory work under proper coordinating supervision.
These area supervisors in each State are being given this supervisory responsibility.

And now let's turn to the animal disease front.

Our banner story this year features the close of an apparently successful campaign
against the foot-and-mouth outbreak in Mexico.

As you know, this is the second outbreak in seven years. The first, from 1947 to
1952 (Slide 3) covered an area of 220 thousand square miles—equal to California,
Connecticut, and Maryland combined. Our government joined that of Mexico in
setting up a Joint Commission to bring the outbreak under control. In the five-year
fight it took to accomplish this, it was necessary to eradicate one million animals
and to vaccinate 17 million more, some as often as four times. The program was
concluded with the opening of the border in September 1952.

The second outbreak occurred in less than a year. The disease was diagnosed in
the State of Vera Cruz in May 1953. A much smaller area was involved. (Slide 4)
Disease eradication techniques worked out in the first campaign were inaugurated
as soon as possible. Trained people were more readily available and the Joint Com-
misson was able to confine the disease much more quickly and to a much smaller
area.

All the known infection had been eliminated by the middle of March of this year.
The Joint Commission agreed upon a follow-up program of intensive inspection and
observation. And in April the Secretary of Agriculture announced he would declare
Mexico free of foot-and-mouth disease December 31, 1954, if conditions continue
favorable. There was a reappearance of disease in test animals on one premises in
April, but there have been no further appearances.

This will automatically open the Mexican-United States border to imports of
livestock and livestock products. And when this is done the inspection and quaran-
tine force—recruited to strengthen the border patrol during the outbreak—will be
greatly reduced.

This campaign has proved the soundness of our present techniques: quarantine,
inspection, elimination of infected and exposed animals, disinfection of premises
use of test animals and continuing inspections.

The States justly join with us in taking pride in the progress that has been made
in eradicating vesicular exanthema. During the year the monthly incidence has
decreased, the percentage of garbage feeders cooking has increased, as has the semi-
monthly inspection of garbage-feeding premises.

The cooking of garbage is new. Practices that are effective and relatively easy to
use have been developed since this outbreak. One of the big jobs in the eradication program was to help farmers learn how to use the equipment and to train inspectors in testing the results. This has been done. As a result, garbage is being cooked better. The quality of inspection has improved. And our relationships with feeders have greatly improved.

The importance of getting the garbage properly cooked before it is fed to swine can't be overemphasized. During the first 10 months of 1954 there were 111 separate occurrences of vesicular exanthema in 15 States: 91 of these occurred in four States, and of these 91, 76 occurred in two States that do not have garbage cooking legislation, and 8 more in one State with an inadequate law.
I would also like to take note of the effectiveness of another technique in reducing VE—California’s practice of restricting the market. This too has brought good returns in reducing the incidence of the disease.

I want to comment briefly on the eradication of bovine tuberculosis. It’s been 14 years since the last of the 48 States was declared a modified accredited tuberculosis-free area. This was a noteworthy milestone in the cooperative State-Federal program. We’re still testing around 10 million cattle a year. The number of reactors to the tuberculin test has been about the same for the past three years—around 0.11 per cent. More and more of these reactors are being located by tracing the animals that show lesions of tuberculosis on regular kill. This past year some 1600 were spotted by this method as compared with not quite 800 the year before. Close cooperation by Meat Inspection Branch with the Animal Disease Eradication Branch has made this possible. Joint plans for the more complete utilization of information provided by slaughter inspection in the control and eradication of disease are being developed by these Branches.

I won’t go into the brucellosis story except to say the prospects for making real gains in the eradication of this costly disease are highly encouraging. More herds and cattle have been tested in 1954 than in any previous year. In 1953, 660,344 herds containing 7,860,870 cattle were tested, as compared to 696,207 herds con-
LIVESTOCK REGULATORY PROGRAMS 35

...taining 9,002,109 cattle in 1954. In 1953, there were 16.4 per cent infected herds as compared to 14.2 per cent in 1954. The percentage of reactors went down from 3.4 per cent to 2.6, which may well indicate the lowest infection rate in the country since testing was begun in 1934, in view of the fact that use of the ring test in several States has resulted in blood testing principally those herds already suspected of being infected. The number of calves vaccinated was increased from 3,688,149 to 3,999,101. In 1953, 670,532 herds representing 12,234,810 cattle were ring tested, as compared to 932,003 herds representing 16,633,034 cattle in 1954.

Near the close of the session last summer, Congress authorized the Secretary of Agriculture to invest $15 million this year and another $15 million next year in an intensive drive on brucellosis. We have now discussed plans for accelerating the program with the State officials and representatives of the American Veterinary Medical Association. They and we are discussing these plans with the Extension Service, industry representatives, and the State Veterinary Medical Associations. As these plans take shape we expect to accelerate and expand the eradication program rapidly. We are hopeful that two years of accelerated, expanded, intensified activity will do much toward eradicating this disease.

This year efforts have been stepped up against scrapie—a disease that has been a threat to the sheep industry of this country since 1947. (Slide 5) As you know, the Department policy is eradication based upon the slaughter of animals infected with or exposed to scrapie.

In July Federal regulations were amended to increase the indemnity paid to owners whose sheep are destroyed because of scrapie and to permit the Federal Government to pay indemnity even when the State concerned is unable or unwilling to do so. These modifications have certainly given impetus to the eradication program.

With the slaughter of 11 flocks during the past four months, all known infected flocks have now been slaughtered. In addition to slaughtering the infected and exposed sheep the program has consisted of disinfection of premises and tracing all movements from infected flocks. Six hundred flocks in 39 States are under surveillance because sheep in those flocks have been associated with the disease. (Slide 6)

The inspection of flocks for scrapie has paid off—in the detection of infected animals and also in alerting practicing veterinarians to be on watch for the disease.

We've assembled the information that's available on scrapie and distributed it to USDA veterinarians, the sheep industry, and others who are interested. We have produced a film on scrapie in cooperation with Dr. Todd of Federal Civil Defense Administration, which is to be shown during this meeting.

One other step—we've drawn up proposals to alter our import regulations for sheep, based upon the nature of scrapie. These have now been reviewed by the USDA Solicitor. If they are finally approved we will have additional authority to protect against the disease.

And now for a brief report on a disease that is becoming an increasingly serious problem here—bluetongue.

You may recall the trouble was first observed in West Texas sheep in 1948, which was reported in 1952 by Hardy and Price under the name "sore muzzle." On the
UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service
Animal Disease Eradication Branch

SCRAPIE IN THE UNITED STATES
From 1947 to October 1, 1954

COUNTIES IN WHICH SCRAPIE HAS BEEN DIAGNOSED

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service
Animal Disease Eradication Branch

SCRAPIE IN THE UNITED STATES
Number of flocks under surveillance
during fiscal year 1954

TOTAL NUMBER OF FLOCKS 576
suspicion that this actually was bluetongue, the Bureau of Animal Industry obtained the help of an expert from South Africa who has had a great deal of experience with the disease—Dr. R. A. Alexander, Director of Veterinary Services, Onderstepoort, Union of South Africa. He came over here and made an intensive survey in the West. When he confirmed their diagnosis, Department research and regulatory workers began at once to study methods of eradicating the disease.

Bluetongue is spread by small insects, *Culicoides variipennis*. The fact that the vector has been identified in practically every State in the country leads us to believe we may expect more trouble from the disease. It was also decided, in the light of our present knowledge, that the disease could not be eradicated. It has already shown up in 10 States—Texas, Oklahoma, Kansas, Nebraska, Missouri, Colorado, New Mexico, Arizona, Utah, and California. The heaviest losses have been reported in California where the disease resulted in the death of 15 thousand animals in 1952.

The encouraging development this year is an effective vaccine that has been developed by cooperative research undertaken by the United States Department of Agriculture, the University of California, and private industry. After this vaccine was approved last June, four firms were licensed to produce it. They have now turned out some two million doses and sheep growers are making extensive use of it to protect their flocks. No unfavorable reports from its use have been received.

Agricultural Research Service is adding to its facilities at Denver to provide research and diagnostic assistance on this disease. It will be possible to send samples from sheep suspected of having the disease to this laboratory for confirmation. And the Department is pushing forward in research, vaccination tests, and surveys to obtain the knowledge we will need to bring bluetongue under control. The Department has also cooperated with Federal Civil Defense Administration in providing a bluetongue film which will be shown at this meeting.

My final highlight concerns an outbreak of a disease that once took much of the profit out of livestock on the range—scabies. As some of you are aware, we had a rather widespread outbreak of psoroptic scabies in Western cattle this year. But the States with some assistance from Animal Disease Eradication Branch moved in on it promptly and were able to bring it under control with a chemical that has been showing up extremely well in State tests—benzene hexachloride.

More than 11 thousand animals in 26 herds were treated with BHC at required concentrations. Altogether 29 thousand treatments were given and the results were uniformly successful. When the veterinarians examined the cattle a month or six weeks after the sprays were applied they found the lesions nearly all healed. And the animals were completely free of scabies mites.

Sheep scabies continues to present a problem. The disease was reported in 21 States this past year. That included New York where scabies has not been found in several years.

Just one other point. In our work no news is good news when we speak of introduced diseases. And this year has been a good one in that respect—thanks to the alertness of the men in animal inspection and quarantine.

A catastrophe that might have occurred if they hadn't detected the disease in
routine tests was the introduction of Asiatic Newcastle disease. This showed up last March in a flock of 166 birds in quarantine at the Clifton, New Jersey station.

As customary at the quarantine station, when the disease was confirmed the poultry were immediately destroyed. The virus, isolated for further study, proved to be a strain of high pathogenicity. In follow-up tests with 20 susceptible hens and 28 broilers, the disease killed every one of them. Think of the losses this would have caused our poultry industry—and the cost of eradicating the disease if it had become established.

This illustrates the threat that we continually face. It has not subsided.

But this past year has given us an opportunity to get on top of a number of problems. We believe we are in a position to make further gains—in detecting diseases and eradicating them. The job is a big one but it can be done if we all work together.
ANIMAL DISEASE RESEARCH UNDER WAY AND PLANNED

B. T. SIMMS*

As most of you know, the work of the Animal Disease and Parasite Research Branch of the Agricultural Research Service is very broad in its scope. It would be impossible to even summarize in this one paper all the work that we have under way. I shall confine my remarks to discussing some of the thinking that is behind our research, pointing out results of some of our activities not covered in papers by my colleagues and outlining some of our plans for the future.

Up to about 70 years ago neither our Federal nor our State governments had laws, personnel, or funds adequate to cope with serious outbreaks of diseases of livestock and poultry. Each owner had to carry most of the responsibility for protecting his flocks and herds from the ravages of diseases and parasites. This task wasn't too arduous in a pioneer country which had neither facilities nor necessity for moving livestock long distances with speed. A hundred years ago a sick cow or pig could spread disease only as far as it could walk; and most sick animals didn't walk very far. Dr. Salmon reported that, in the pre-railroad period, it took 50 years for tick fever to spread 200 miles in North Carolina; but that this was "under very favorable conditions." In other States it moved less than two miles a year.

But by the middle of the last century our country was changing from one made up of many small, self-sufficient communities to a nation with rapidly growing intrastate and interstate commerce. With this change came the necessity of something more than "rugged individualism" in controlling and preventing disease. Far-sighted leaders among our livestock producers realized transmissible diseases were serious handicaps to livestock production and urged the Congress to enact a law setting up the Bureau of Animal Industry. Out of necessity, then, our research program was born.

This new bureau was assigned responsibility for finding the causes of disease and their methods of spread; such knowledge to be used in the "extirpation" and prevention of disease. It is of interest to note that research with diseases caused by viruses, bacteria, protozoa, helminths, and plant poisons was begun almost immediately. And, always the final objective was facts that would be of practical value in controlling, eradicating, and preventing disease. These objectives have never changed.

Our research today, just as it was 70 years ago, is planned and carried through with the final goal being living without disease. We are dedicated to the development of information and means of making this possible.

It takes more than wishful thinking to activate and maintain an animal disease research program. The very nature of the work makes it costly. Animals for experiments, quarters in which to house them, feed and care for them, and laboratory buildings for the research workers are all very expensive.

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Fortunately some of the early research was very productive. When the livestock producers and State sanitary officials saw practical results coming from this research they originated and supported requests for increases in funds for this work. Something else happened too. As soon as it was demonstrated that research could find answers to certain disease problems, requests for help multiplied. Old unsolved problems became more serious and new problems arose. This was partly because control of disease tends to spread disease. Let me illustrate: As long as tick fever was present in the South and a quarantine prevented the movement of cattle from southern farms and plantations to tick-free northern areas the small stomach worm, *Ostertagia ostertagi*, remained restricted to the South; but when ticks were eradicated and quarantines revoked this parasite moved north with southern cattle. And when cattle from tick-free areas could be moved into the South and Southeast, tuberculosis moved in with them. All the older men here have seen brucellosis and mastitis introduced into herds with replacements for cattle reacting to the tuberculin test and Johne's disease and vibriosis brought in with replacements for cows with brucellosis or mastitis. So we have never caught up. Before we had done a thorough job with tuberculosis we had to study brucellosis and mastitis; before we had finished with them Johne's disease and vibriosis were acute problems. Always as additional funds were provided, additional problems were crying for solution. Of course, we have never had enough financial support. That applies to practically all our activities, whether they be personal or governmental.

It has been estimated that diseases and parasites of livestock and poultry cost our country more than two-and-a-half billion dollars annually. Funds spent to reduce this staggering amount should be considered as investments. If, by using a tax dollar, we can save the taxpayers ten dollars or a hundred dollars, the investment would, by all accepted standards, be considered a wise one. For example: We probably have at least two million fewer cattle in our country with brucellosis today than we would have if control and eradication programs had not been undertaken; and we could have had no such program without research. These cattle are surely producing more than $25.00 each above what they would produce as Brucella-infected cattle. This means 60 million dollars annually; a big dividend on the money spent for research and eradication. Incidentally, please let me make it clear that research pays cash dividends only when its results are applied in the field and the biggest profits come when a disease is eradicated. It seems probable that research with hog cholera, productive though it has been, will declare its biggest dividends only when this disease has disappeared and we are living without hog cholera.

From a very small beginning our funds for research with animal diseases and parasites have grown through the years. Since World War II ended we have had several good increases in our budget. In fact, during this period the Bureau of Animal Industry had a greater percentage increase in its research budget than any other bureau in the Agricultural Research Administration. But always there are new diseases or new manifestations of old diseases; so we are never able to do all the research that is needed and demanded.

A partial list of the work activated since World War II includes research projects with hyperkeratosis or X-disease of cattle, bloat, vibriosis in both cattle and
sheep, chronic respiratory disease and Newcastle disease of poultry, blue tongue in sheep, atrophic rhinitis in swine, variant hog cholera virus, vesicular exanthema in swine, diseases of young pigs, foot-and-mouth disease, and many parasitic diseases. We have changed the emphasis of many of our older projects. Our studies of diseases caused by acid-fast organisms, for example, are now concerned mainly with development of better diagnostic agents and methods. We have expanded and are continuing to expand our work with infertility in cattle. Both protozoan and helminth parasites are receiving increased attention. We have increased very materially the amount of work that is being done in cooperation with the different State experiment stations. We are continuing our cooperative research with foot-and-mouth disease in some of the European laboratories; and we are doing a limited amount of work in Africa. Thus, we are supplementing our very meager facilities by utilizing those of our coworkers both at home and abroad.

May I mention briefly some of the results coming from current research? Definite progress has been made in improving the technique of the tuberculin and the "johnin test." Use of tuberculin, johnin, and avian tuberculin at the same time is proving helpful in some NVL herds. And use of the cervical region for injection of tuberculin is aiding in detecting infected cattle in some "problem" herds.

Continued studies of the milk of Brucella-infected cows have further emphasized the frequency of udder infection in such animals. Present data indicate not less than 70–75 per cent of infected female cattle shed Brucella organisms in their milk. This points out again the danger of the suckling calf as a source of infection. I believe some of us have not placed sufficient emphasis on the possibility of spreading brucellosis by infecting pastures with feces from calves that are suckling infected dams. We have published results of exposure of female cattle revaccinated with Strain 19, but, since this procedure is still being recommended, I'm calling attention to them. We did not increase resistance to Brucella abortus by revaccinating.

We are asked very often just how much resistance to brucellosis is developed in cattle properly vaccinated with Strain 19 Brucella vaccine. A summary of results of exposure of all vaccinates and their controls at Beltsville may be helpful in answering this very important question. Forty-one per cent of all vaccinates and 91 per cent of all controls exposed experimentally contracted the disease. These results are not out of line with data reported by other research workers. As is indicated by the very high percentage (91) of infection in exposed controls the exposure dosage was usually rather large. It is very probable that the differences between percentages of infection in vaccinates and controls would have been more marked if exposures had been somewhat smaller. Had we reduced the exposure dosage to the level that would have resulted in infection in only 50 per cent of the controls it is quite possible not more than 15 per cent of the vaccinates would have become infected.

Infertility in cattle is being traced to either vibriosis or trichomoniasis more and more frequently. At least some of what has been called "functional sterility" can be ascribed to these infections. Better methods of handling these diseases are being developed.

Our work, as well as that done by other research groups, is making it increasingly
clear that subclinical infestations with parasites may cause serious economic losses. Only a few ascarids in a pig may slow down growth 10 per cent or even more. Mild coccidiosis, light infestation with lung worms, or subclinical infestations with the common gastrointestinal parasites of cattle may affect rate of gain and quality of young cattle sufficiently to make their production unprofitable. It is very probable that inapparent infestation with internal parasites is even more costly than gross parasitism.

What about the future? Many big livestock health problems remain either unsolved or partly solved. Mortality in young animals has long been very serious. Some few years ago it was estimated that 10–20 per cent of our chicks, 20 per cent of our dairy calves, and 30–40 per cent of our pigs died in the early weeks of their lives. Reduction in losses among baby chicks has been phenomenal, but little progress has been made in decreasing these losses among calves and pigs.

As we move more and more cattle from range or farm to pastures or feed lots in other States or areas the shipping fever complex becomes more serious. It is not unusual to have a cattle feeder say this disease or group of diseases costs him $10 to $20 per head. Occasionally these losses are as high as $50 per steer. We have no satisfactory answers to the questions being asked as to methods of preventing these losses. Infectious keratitis and anaplasmosis in cattle, atrophic rhinitis and swine erysipelas, lymphomatosis in poultry, and ornithosis in turkeys are only a few of the well established transmissible diseases that demand our attention. We should also study some of the new or previously unrecognized diseases, such as mucosal disease and similar disturbances in cattle, eperythrozoonosis in cattle and swine, and gut edema and virus pneumonia in swine. As our pastures are improved and our livestock population per acre increases internal parasites will become increasingly serious. We—and now I’m speaking of all research workers with animal diseases—must increase the amount of productive research being done in our country. Additional facilities, increases in staff, and additional financial support are necessities. Equally necessary are better trained workers, better planned research, and ever closer coordination between laboratory and field activities.

As research men we must not be content to be defensive players only. A strictly defensive game can lead to nothing better than a tie; and our opponents never quit or take time out so long as they are playing a tie game. You know we held the line and punted on first down with vesicular exanthema for 20 years. Then, in the last quarter an explosive offensive pushed us back in the shadow of our goal posts. We almost lost the game.

How easy it is to say now that the research with vesicular exanthema that was started two years ago should have started 20 years back; that facts only recently discovered should have been available when this disease was present on only a few hog ranches in one State; and that, with such knowledge, an eradication program would have been easy! Those of us who know a little about conditions existing at that time realize funds were hard to come by, other problems seemed more acute and important, and diversion of any considerable portion of research funds to work with this disease would very probably have brought on severe criticism. We must not be critical but we must profit from our experience with vesicular exanthema.
We must realize quarantines and vaccines are defensive measures and that they should be only temporary. Our objectives must be the development, through research, of techniques and procedures which will enable our coworkers in the field to adopt and carry out aggressive tactics and strategy. Eradication of transmissible diseases and parasites must be our final end point.

It can’t be done? People have always known it couldn’t be done. We couldn’t stamp out pleuropneumonia; we couldn’t find means of eradicating fever ticks and put them into effect; we couldn’t discover a preventive for hog cholera and control the catastrophic epizootics which used to decimate our swine population; we couldn’t work out practical procedures for eradicating brucellosis from our cattle herds; we couldn’t develop a reliable and economical method of large-scale testing for dourine and use it in the field to eradicate this disease; but we have done all these things.

As we see it the future is bright. We know the game won’t be easy; but it can be won. We can, through research, continue to discover new facts and develop new knowledge which can be used to make livestock and poultry production safer, more economical, and more profitable. We must do this if our ever-growing population is to be well fed.
REPORT OF COMMITTEE ON REVISION OF THE CONSTITUTION AND
BYLAWS

R. W. SMITH, Concord, New Hampshire, Chairman

DR. SMITH: Mr. President and members of the Association, this report and amendments which I will present to you are merely corrections to bring our Constitution up-to-date. They are nothing new, as you will learn.

Your Committee on Constitution and By-laws wishes to recommend the following:

1. Amend Article III line 19 of the Constitution by inserting after Puerto Rico and the Virgin Islands "and Los Angeles County, California" so that Article III as amended will read

2. Article III

17 There shall be two kinds of members,—Official and Individual.

18 The livestock sanitary departments of each State as so the United States, and the Canadian, Cuban and Mexican governments, the Territories, Puerto Rico and the Virgin Islands and Los Angeles County, California shall be eligible to official membership in this Association and be represented on the Executive Committee by the livestock sanitary executive official.

22 Any person engaged in livestock sanitary work for federal, provincial, state, territory, county or municipal governments and any other person interested in livestock sanitation or milk and meat hygiene may be elected to individual membership.

23 Amend Article V, lines 34 by deleting the words "(the Chief of the United States Bureau of Animal Industry)" and insert in its place "the Director of Livestock Regulatory Programs, Agricultural Research Service, United States Department of Agriculture"

In line 38 insert "(Los Angeles County, California)" after Virgin Islands

Article V, lines 34 through 42 would then read as follows:

Executive Committee

34 The Executive Committee shall be composed of the executive officer representing the livestock sanitary departments of the respective States and Territories, the Director of Livestock Regulatory Programs, Agricultural Research Service, United States Department of Agriculture, the Director-General of Canada, the executive regulatory officer of Cuba, Mexico, Puerto Rico, the Virgin Islands, Los Angeles County, California and the elected officers of this Association.

39 "The Executive Committee shall constitute the administrative body of the Association, and shall determine its activities and policies. All recommendations and reports of officers and committees shall be referred for consideration to the Executive Committee."
Mr. President, I move that this report of the Committee on Constitution and Bylaws be presented to the Executive Committee, to lie over, as provided in the Constitution, for one year, for their discussion and action at the annual meeting in 1955.

These amendments will go in as amendments from the Committee on Revision of the Constitution and Bylaws, and will have to lie over for one year, for action next year.
DR. HENDERSHOTT: As you know, some two years ago, when vesicular exanthema broke in this nation, the Secretary of Agriculture asked that an advisory committee be appointed to confer with him relative to the operation of control and eradication measures.

This advisory committee is made up of representatives of the railroads, livestock markets, major markets, the regulatory officials, members of the Agricultural Research Service, the meat packers, garbage feeders, the American Veterinary Medical Association, the United States Livestock Sanitary Association and the American Farm Bureau Federation and the National Grange.

This advisory committee provided an opportunity for many of us to become acquainted with others in the livestock business, both in production and marketing, transportation, meat packing, and so on.

Two meetings were held in 1952 and 1953, and if my memory serves me correctly we had but one meeting this year, in June.

In the earlier meetings we set up a program of control and eradication. The initial meeting was one largely of briefing the remainder of the representatives of industry with the disease, how it was spread, and the nature of it, and to bring them up-to-date on the current information available to us through what research work had been done.

A good many of our decisions at that time were based on the knowledge we had of foot and mouth disease and the research that had been done on foot and mouth disease, largely in the countries outside the United States, since we were not permitted here to experiment with the dangerous virus of foot and mouth disease.

Unfortunately, vesicular exanthema had been in California for twenty years, and we had little accrued knowledge of the disease in the United States.

Out of those early meetings we tried to provide information that was not readily available, and distribute it. We asked the United States Department of Agriculture at that time to prepare a pamphlet on vesicular diseases, their causes and the manner in which they were spread, and what might be done to help eradicate and prevent their rapid spread.

Considerable discussion took place with regard to the cleaning and disinfection of major yard facilities, transportation facilities, and so on, since it was through transportation, as we all know, that the rapid spread of this disease occurred.

Programs were inaugurated. We felt we needed two things. One was to stop the spread or transportation of animals out of infected and exposed herds, and the other was to put a stop to the introduction into herds of virus-carrying food material. Little was known among all of us about the proper means of cooking garbage or the best equipment available to do an economical job of cooking animal food material.
We also found ourselves in a majority of states without any legal authority to enforce or to cause those people to cook their garbage prior to feeding it.

A uniform bill was drawn up, a model bill for legislative action, and was offered to the respective states, with all of the encouragement and help we could give them in passing legislation, to provide for the mandatory cooking of garbage fed to animals.

In June of this year we met again to review what progress had been made. It was very enlightening and very pleasing to most of us to realize that through the efforts expended by the agencies in charge of disease control, and others who were interested in aiding us in having legislation passed, forty-three of the states had cooking laws, either by legislation or by regulation. The disease that had been prevalent in the central part of the United Stats in a large measure had been eradicated.

In reviewing the situation in the early summer of this year, we found that vesicular exanthema had not been reported from the great corn belt area, and that we had the disease apparently chased from the interior of the country back into California, from whence it had originated, and through the rapid spread of the disease it left us with an eastern seaboard area that was still infected.

This was what most of us anticipated would occur when the disease started on its way, because the conditions on the eastern seaboard and those in California are somewhat akin. I haven't been in California to critically review their situation, but I don't think they have perhaps quite the problem we have in the eastern seaboard area.

We also reviewed the activity of the control agencies in this particular disease control effort, and it was felt that in certain areas there had been more or less a dragging of feet, that those in high office had not been as active or as interested in
enforcing or endeavoring to get regulations or enforcing what orders of the boards they had in their respective areas.

Quarantines were not being rigidly enforced. Inspection of movement of swine was not being rigidly enforced. In other words, there seemed to be a lack of wholehearted cooperation on the part of some people with respect to the control program.
The Agricultural Research Service had met individually with the officials in several states that were not actively engaged in a good disease control program, and simply laid before them the picture as they saw it, with the threat that unless greater cooperation was shortly forthcoming it might be necessary to place a quarantine on the entire state and prohibit the movement of swine, period.
This has had a salutary effect, as I see it, and at the present time there is more interest in endeavoring to do an eradication job. A new program was offered which varied very slightly from one previously offered to the states in the control and eradication of this disease. The Department of Agriculture offered greater personnel assistance to the states. There was an improvement in the number of federal government employees placed in these areas to check on the movement of swine in interstate commerce. The states were encouraged to increase their personnel to insure semi-monthly inspections made of all garbage feeding ranches.

This has been done to a large degree in the eastern seaboard area. I know in my own State we have a record of every garbage feeder. Even from the very outset we have earnestly sought them out. At one time I thought perhaps we were too active in that respect when compared with other states in the Union, because we knew pretty much from the late summer of 1952 the location and the number of hogs generally fed garbage on our farms. We recognized also that the State in which I happen to be an official is a comparatively small State, and it is relatively easy to seek out these garbage feeders. It is however a task that must be accomplished in each State if we are to succeed in eradicating vesicular exanthema and later on hog cholera.

For a long period of time we in New Jersey have conducted semi-monthly inspections, although I notice that some of the reports coming out from the Bureau hardly credit us with doing a 100 per cent job.

Improvement is being made in the control and eradication of the disease in the eastern seaboard area, and at the meeting of the advisory committee in June the situation as it has developed in California was very graphically presented and it was encouraging and enlightening to all of us to see the progress that was being made in California.

At the time of that meeting there were twenty-one northern counties in the State of California in which the federal government found itself able to quarantine the infected premises and to release the county-wide quarantines that had been imposed. In that area a great many of the raw garbage feeders were no longer feeding raw food to their pigs, but were feeding cooked garbage, and they were adequately cooking it.

The question was discussed at the meeting concerning the possibility of sending a letter to all of the states in the Union congratulating those that had made progress in the control and eradication of vesicular exanthema, and presenting to the secretaries of agriculture and the chief regulatory officials of all states the exact situation that that particular state was in with respect to its cooperation in the eradication program.

It has been my experience, in observing this cooking of garbage, that we have a lot of engineering concerns that are certainly foisting themselves on the public and are taking some of our garbage feeders for a merry ride as far as their equipment is concerned.

Anybody who has any kind of a device that will emit steam proclaims that it is good piece of garbage cooking equipment. Unfortunately, in some areas they have sold quite a few pieces of equipment to garbage feeders that is inadequate to do the job. It is imperative, in my opinion, that we look over the pieces of engineering
equipment that are being offered, and warn our people that in making an examina-
tion we are going to determine the effectiveness of their equipment on a tempera-
ture reading of the garbage after it has stood a while after they have discontinued
applying heat to it.

There are a number of good pieces of equipment on the market that are not too
expensive and that are really capable of doing a good job.

We have made progress. It has been rapid in some areas, where we had complete
cooperation of the farmers, and it has been dragging a little bit in those areas where
farmers have resisted any regulatory official’s recommendation relative to cooking.

It is good to see that the resistance has broken down in California, because that
was the hub of the resistance, and it was California to which many of the garbage
feeders went for their thinking and advice. If we can hold our own for another year
I am quite sure we will see the end of this particular virus disease.

The Advisory Committee has been very helpful and no doubt will be continued
until the complete eradication job has been accomplished.
It will be noted at once that the new title conforms to the realignment of the U. S. Department of Agriculture.

During 1953 suggestions were received by the Poultry Division urging that certain changes be made in poultry standards for quality and a few other provisions of the regulations governing the grading and inspection of poultry. These were prepared in proper form and distributed to members of the poultry industry, college and extension workers, state marketing officials and others interested in poultry and inspection work.

A meeting was held in Washington on April 29 and 30, which was attended by your representative. Briefly, all of the suggested changes were presented to the group and discussed. Final decision as to the changes was to be made by the Poultry Division.

A meeting of the Public Health-Industry Technical Advisory Group, planned for early March of this year, was cancelled because of a conflicting meeting with the United States Public Health Service which is developing a model sanitary code on Poultry Ordinances. No meeting has been called to consider this code.

Under date of July 28, Dr. Roy E. Willie, Chief, Inspection Branch, Poultry Division, distributed material to be used in a revision of instructions governing Disposal of Diseased Poultry, Carcasses, and Parts. This was sent out for discussion purposes, only. Following usual procedure, a meeting will be called at which these revisions will be considered. Such a meeting has not been called up to this time.
Mr. President, Ladies and Gentlemen:

On May 13, 1954 the annual meeting of the National Brucellosis Committee was held in the Chicago Room of the LaSalle Hotel, Chicago, Illinois. The meeting was called to order by the President, W. D. Knox. The following members and guests responded to the roll call.

H. C. Aaberg, American Farm-Bureau Federation
B. D. Ball, Michigan Department of Agriculture
T. H. Bartilson, Extension Service, USDA
Dick Braun, "Farm Journal"
Acord Cantwell, Indiana Farm Bureau
J. F. Cavanaugh, Purebred Dairy Cattle Association
Harry Cohen, Chicago Board of Health
J. H. Colby, "Morning Democrat" (Davenport)
W. H. Coulter, American Meat Institute
R. L. Cuff, Livestock Conservation, Inc.
J. W. Cunkelman, Swift & Company
T. F. Danforth, Chicago Board of Health
L. R. Davenport, Illinois Department of Public Health
Lee Davison, State Veterinarian (Michigan)
W. M. Decker, Michigan Department of Health
F. C. Driver, ADE Branch (St. Paul)
W. W. Fuque, Missouri Farm Bureau Federation
A. D. Gates, American Medical Association
V. W. Gesellchen, Corn States Laboratories (Omaha)
E. H. Gloss, Minnesota Live Stock Sanitary Board
C. H. Hays, Fed. Veterinarian In Charge (Michigan)
K. K. Heideman, Wisconsin Farm Bureau
R. J. Helvig, U. S. Public Health Service
K. E. Hood, American Farm Bureau Federation
E. G. Huffer, Illinois Public Health
L. M. Hutchings, Purdue University
F. J. Keilholz, "Country Gentleman"
H. E. Kingman, Jr., American Veterinary Medical Assn.
W. D. Knox, American Agricultural Editor's Assn.
A. K. Kuttler, ADE Branch (Washington, D. C.)
R. H. Lage, Davenport, Iowa
REPORT OF REPRESENTATIVE

MRS. S. K. MADDUX, Committee on Boys' & Girls' Club Work
J. P. MASON, Illinois Agricultural Association
KARL MAYER, "North American Veterinarian"
D. N. MCDOWELL, Wisconsin State Dept. of Agriculture
S. H. MCNUTT, Land-grant colleges & universities
A. K. MERRIMAN, Illinois Department of Agriculture
U. H. MEYERS, United Press
J. B. NANCE, National Hampshire Association
C. F. NEUMANN, National Livestock & Meat Board
H. S. NICOL, Iowa Farm Bureau
H. J. O'CONNELL, State-Federal Veterinarian (Wisconsin)
M. V. O'CONNELL, Livestock Conservation, Inc.
R. E. OMOHUNDO, ADE Branch, Missouri (Jefferson City)
RICHARD ORR, "Chicago Daily Tribune"
A. M. ORUM, American Veterinary Medical Assn.
G. E. PARSONS, Dairy Extension, Michigan State College
T. H. PHILLIP, State Veterinarian's Office (Indiana)
J. R. PICKARD, Livestock Conservation, Inc.
GREGORY PIETRASZEK, "National Provisioner"
J. W. PIRIE, National Association of Artificial Breeders
G. R. REED, Extension Veterinarian (Michigan)
P. W. SCHINSCHIL, Pure Milk Association
C. G. SCRUGGS, "Progressive Farmer"
J. E. SEIBERT, "Michigan Farmer"
R. W. SMITH, U. S. Livestock Sanitary Association
W. W. SPINK, University of Minnesota
J. H. STEELE, U. S. Public Health Service
E. E. STOCKEBRAND, Kansas Farm Bureau
E. W. TIEDEMANN, American Farm Bureau Federation
J. P. TORREY, E. I. duPont Company
J. R. UNDERWOOD, Extension Director, (Davenport, Iowa)
C. D. VAN HOUWELING, Agricultural Research Service, (Washington, D. C.)
R. L. WEST, State Veterinarian, Minnesota
W. E. WINN, Pure Milk Association

Next in the order of business were remarks by our President W. D. Knox. As his remarks were short and timely, I will quote them to you.

"Before I step aside as President of the National Brucellosis Committee, I would like to comment on the accomplishments of this committee. Perhaps we have not accomplished as much as we would have liked to, but in 1947 and 1948 there were many differences of opinion facing us. I believe you can appreciate very well the unification of thought that is present now and that all of our time spent has been worthwhile. The formation of this industry committee to work in the field of research, education and promotion has brought about as close to complete unification as we could hope."

"Interstate health regulations, considered impossible some few years ago, were accomplished last fall. Missouri and Nebraska indicate very material and marked progress. In my own opinion, brucellosis is not a major livestock health problem
today. It is going to be stamped out in shorter time than we anticipated, but only with continued and extended joint effort. In our own state of Wisconsin, the state legislature hopes to develop plans to be free of this plague of brucellosis within the next two years. I believe the coming meeting of the Illinois Department of Health and Agriculture to interpret Grade A milk requirements for the Chicago milk shed will set a definite pattern for other major markets."

"I personally thank you gentlemen and Livestock Conservation, Inc., for the way you have assisted me. We have much to discuss at this meeting, and I am sure that our programs will show positive results in the very near future."

Next in order of business was the report of the Nominating Committee which brought in the following names, all of which were unanimously elected and sworn in for the ensuing year.

President .................................................. H. C. Aaberg
1st Vice President ................................. T. F. Arnold
2nd Vice President ................................. W. D. Brittin
Secretary ........................ ......................... J. R. Pickard
Ass't Secretary ........................ ............... J. F. Cavanaugh
Treasurer ................................ .................. J. G. Hardenbergh
Ass't Treasurer ........................ .................. H. E. Kingman, Jr.

The Executive Committee consists of the following:

H. C. Aaberg W. H. Coultas W. D. Brittin
T. F. Arnold W. D. Knox J. H. Steele
J. F. Cavanaugh C. F. Neumann W. A. Wentworth

The Board of Directors to be elected in 1954 for a three-year term are as follows:

T. H. Bartilson A. K. Kuttler J. H. Steele
J. F. Cavanaugh W. D. Knox A. M. Orum
L. M. Hutchings S. H. McNutt R. W. Smith

The feature of the morning session was a panel discussion composed of:

Dr. C. D. Van Houweling, Director of the Livestock Regulatory Programs, United States Department of Agriculture; Dr. R. J. Helvig, Public Health Service; E. G. Huffer, Illinois Public Health; W. E. Winn, Pure Milk Association; J. B. Nance, National Hampshire Association; T. F. Arnold, American National Cattlemen's Association, and moderated by W. D. Knox. The following materials were presented at the panel discussion:

"Interstate Regulations Pertaining to Brucellosis" by Dr. C. D. Van Houweling, Director, Livestock Regulatory Programs—United States Department of Agriculture.

Doctor Van Houweling stated in part as follows: "Speaking in regard to the federal Government's stand on the restriction of the interstate movement of brucellosis-infected livestock, regulations are being developed in cooperation with state and local regulatory officials. In order to obtain complete cooperation and to develop the most sensible approach to a workable intra and interstate program, such harmony is essential."

Doctor Van Houweling cited the proposed interstate regulations for brucellosis which were submitted in September of 1953 and now affect the interstate movement of livestock.

Next on the panel was a paper on: "New Standard Milk Ordinance and Its Effect
On Brucellosis Control Programs" by Dr. R. J. Helvig, Assistant Chief, Milk & Food Branch, Division of Sanitation, Public Health Services.

Dr. Helvig was followed by E. G. Huffer, Milk Sanitarian, Illinois State Department of Public Health. Dr. Huffer covered the subject: "New Standard Milk Ordinance and the Brucellosis Control Program at the State Level."

In summarizing, Dr. Huffer had this to say: "The forces which can be depended upon to support the eradication of brucellosis, there are milk ordinances administered and enforced by public health authorities, livestock sanitary laws enacted by state legislatures and the expert knowledge of veterinarians and livestock owners that can be counted upon to successfully eradicate brucellosis as a livestock disease. The dividends paid to livestock owners in the form of increased milk production, increased calf crops and a reduction in the incidence of brucellosis in the rural population are well worth the effort and cost of a program intended to stamp out brucellosis."

Mr. W. E. Winn, President of the Pure Milk Association was next on the panel, speaking on the subject "Problems Arising in Complying with Grade A Milk Requirements in the Chicago Milk Shed Area." In closing his remarks he stated as follows: "The elimination of losses due to Bang's disease on farms, presently estimated at $100,000,000 annually to the Nation, quickly translates into lower prices to consumers. The more efficient production that will be possible will permit dairy products to sell more competitively with the substitutes that have taken our markets. Our goal in not too many years through better breeding, feeding and elimination of disease, should be a 50 per cent increase in the 5600 pound average per cow that exists today. No more important step in this direction can be taken than to determine how, on a national basis, we can most reasonably progressively and economically rid our industry of this scourge."

"Brucellosis and the Swine Industry", was discussed by James B. Nance, Secretary, National Hampshire Association. In his closing remarks he stated: "The operation of getting rid of brucellosis is an expensive one, but it can be accomplished. We have well developed systems of testing and the general scientific know-how to get the job done. The work of the cattle people tells the tale of costs, particularly in the purebred end, but the swine raisers contribute much to the economy and should be recognized and his problems appreciated by others. Give the swine producer an even break and the guidance to stamp out Bang's disease and you'll have little trouble with this disease in the swine industry."

Mr. Thomas F. Arnold from the American National Cattlemen's Association spoke on: "Interstate Movement of Calfhood Vaccinates."

First on the program in the afternoon session was a review of the States' brucellosis programs by Dr. A. K. Kuttler, Animal Disease Eradication Branch, Agricultural Research Service, United States Department of Agriculture.

Doctor Kuttler reviewed the policy followed in each and every State in eradicating brucellosis. He gave the amount of money spent by both the State and Federal Government in each State for brucellosis eradication during the year 1953, together with the percentage of cows tested and the percentage of heifer calves vaccinated. Doctor Kuttler's report was very comprehensive, informational and interesting. Doctor Kuttler stated in part as follows: "From the tabulated infor-
mation showing progress being made in each of the States on a Regional basis for the fiscal year 1953, you will note the Northeastern Region has tested more than twice as many cattle and vaccinated more than twice as many calves, from the standpoint of percentage, than in any other region. Moreover, the percentage of infection is lower for the Northeastern States than for any other region. This is especially significant when it is understood that the degree of infection was relatively high at the time the program was begun in the Northeastern States, as compared to other regions. Practicing veterinarians have done most of the work in the Northeastern Region."

Dr. J. R. Pickard—General Manager, Livestock Conservation, Inc., followed Dr A. K. Kuttler on the program. He took for his subject "Brucellosis Program in Livestock Conservation, Inc."

You will recall that brucellosis became an integral part of the program of Livestock Conservation, Inc. in May 1952, when the National Brucellosis Committee became affiliated with Livestock Conservation, Inc. At this meeting the National Brucellosis Committee pointed out that they felt the proper approach to the problem was to develop and coordinate a national educational program extending to the State and County level. Doctor Pickard outlined what his organization proposed to do with the limited funds made available to him by the National Brucellosis Committee.

The remainder of the afternoon was devoted to reports of the Subcommittees on Education and Information; Research; Organizational Procedures; Public Health, and Finance.

The report of the Subcommittee on Finance was far from encouraging, and their report reads as follows:

"In an effort to raise funds for the operations of this committee and its agreement of collaboration with Livestock Conservation, Inc., assignments were made to individual members of this subcommittee and others for solicitation of support from interested groups. Specific allocations were made to each of these groups the total of which was in excess of $40,000 sought for the budget. This occurred in March 1952. The subcommittee has been diligent in its efforts but has succeeded in obtaining only $4,397.86. The lack of interest on the part of certain groups is surprising to say the least."

In closing I will say that it is my personal opinion that the National Brucellosis Committee has done a very commendable job to further the program of brucellosis eradication. If it has done nothing more, it has stimulated interest in many groups of people engaged in one way or another in the livestock industry and human health. When the program of brucellosis eradication has been completed here in the United States, The National Brucellosis Committee and those who have worked with it can rightfully feel that they have been a part to this great program.
Report of Advisory Committee to the Agricultural Research Service on Program and Budget

Jas. R. Hay, Chairman, Columbus, Ohio; W. L. Bendix, Richmond, Virginia; H. U. Garrett, Des Moines, Iowa; R. A. Hendershott, Trenton, New Jersey; A. P. Schneider, Boise, Idaho.

On June 24, 1954, a meeting was held in Washington, D. C. with representative of the Regional Livestock Regulatory Officials Group and representatives of the Agricultural Research Service relative to the 1956 Federal Budget. Doctor A. P. Schneider, Boise, Idaho, represented the Western States Regulatory Officials; Dr. H. U. Garrett, Des Moines, Iowa, Central States Regulatory Officials; Dr. R. A. Hendershott, Trenton, New Jersey, Northeastern States Regulatory Officials; Dr. W. L. Bendix, Richmond, Virginia, Southern States Regulatory Officials; and Dr. James R. Hay, Columbus, Ohio.

This group met with Dr. M. R. Clarkson, Deputy Administrator, Regulatory Programs; Dr. C. D. Van Houweling, Director, Livestock Regulatory Programs; and various directors and assistant directors of the Agricultural Research Service.

The discussions at this meeting were confined to those concerning the 1956 Federal Budget and the following points were discussed:

1. Continued support for Federal participation in indemnity funds for tuberculosis and brucellosis.
2. Appropriation of $117,000.00 to match a like fund by the State of Florida to establish the Hog Cholera Eradication Pilot Test Area.
3. Establishment of funds for research in those states where matching funds are available in the sheep disease known as "Scrapie."
4. Increases in indemnity funds where Federal participation is requested to provide payments on the basis of replacement value rather than market value in the eradication of "Scrapie."
5. To make available Federal funds for the eradication of scabies in both cattle and sheep.
6. The estimated appropriation of $1,200,000.00 for the increased enforcement of interstate health requirements from a Federal level.
7. Reactivation of Amendment 15 to BAI Order 376 to provide information to State Disease Control Officials of the shipment of Live Biological Products into the respective states, and for the controlled distribution of diagnostic agents (tuberculin, rapid plate antigen, and milk ring test antigen for brucellosis) to be distributed only through state and regulatory officials.
8. Requested funds estimated at $50,000.00 for the establishment of Morbidity-Mortality Program.
9. To make funds available for research of Anaplasmosis, with particular references to the investigations of a vaccine as described by Dr. Alexander of South Africa.
10. To make funds available for research of—Leptospirosis.
11. To make funds available to study the conditions known as Vibriosis. (We
were informed that $75,000.00 had been allocated to conduct work on this particular condition at Beltsville, in the present budget.)

12. To make funds available for research of Atrophic Rhinitis. (We were informed that $35,000.00 had already been made available for this purpose.)

13. To make funds available for investigation of Blue Tongue. (We were informed that increased laboratory facilities were being established in Colorado for this purpose.)

It is recommended that the United States Livestock Sanitary Association appoint an Advisory Committee selected from the District Geographical Regions of the United States to confer at regular intervals with the Agricultural Research Service, United States Department of Agriculture, on matters of importance to the Nation such as legislation, policy, and finances.
REPORT OF THE COMMITTEE ON LAWS AND REGULATIONS


This year your committee has endeavored to revise the Standard Regulation to more closely conform with the provisions of the regulations of more states. In looking over the various state regulations it is evident it will be quite impossible to prepare a regulation which will meet the requirements of all states. In writing deviations livestock sanitary officers are requested not to quote the entire regulation where the meaning of the Standard Regulation is essentially the same but worded differently. Careful study will show that many state regulations are basically the same as the Standard Regulation but phrased differently.

Ordinarily the health requirements of sheep, dogs, poultry and psittacine birds are under the supervision of the department of agriculture, the state veterinarian or the sanitary board of a state. However, if they are under the jurisdiction of another department, such as the board of health or the sheep commission, this information should be noted under "Deviations", and the name of the department responsible given with complete address and telephone number.

With a more concerted effort on the part of the various states to cooperate with the Animal Disease Eradication Branch, Agricultural Research Service, U. S. Department of Agriculture, in reporting certain diseases, such as scabies in sheep and cattle, many unreasonable regulations can be modified or possibly eliminated. The movement this year on the part of all states to agree to report immediately all cases of scabies in sheep and cattle to the Animal Disease Eradication Branch, who in turn will report to all states, is a forward step in the eradication of this disease on a national basis. Other diseases can be handled similarly and to the betterment of the livestock interests in all states.

Your committee has prepared a health certificate and test chart for your consideration. It contains what appears to be all of the essential information needed at this time and differs from most such certificates now in use only in size, color of paper, and minor changes in wording and arrangement. As has been requested by the railroad companies, a uniform color is desirable and they have suggested that the copy for the carrier be printed on pink paper. They feel this will do much to lessen confusion as to what kind of a certificate they are receiving. Therefore, we are recommending that the copy which accompanies the animals be pink, the copy to the state of destination yellow, the copy to the Animal Disease Eradication Branch, Agricultural Research Service, United States Department of Agriculture, white, and the home office copy goldenrod. The yellow, white and goldenrod colored copies to be sent to State Veterinarian for approval and transmittal.

Also, your committee has prepared a Summary covering the interstate move-
ment of cattle and recommends that it be made a part of Circular 1. This should be available as such to all railroads, airlines, veterinarians and others desiring it. Similar summaries covering other species of animals should be prepared for distribution and issued by the United States Livestock Sanitary Association.

Your committee is submitting a revised Standard Regulation, which it believes should be approved by this association and printed in the front of Circular 1, if it is reprinted before the next meeting.

**STANDARD REGULATION GOVERNING THE INTERSTATE MOVEMENT OF LIVESTOCK, DOGS, PETS, POULTRY, BIRDS, WILD ANIMALS AND BIOLOGICS: AND SANITARY STANDARDS GOVERNING THE CLEANING AND DISINFECTION OF CARS, TRUCKS AND CONVEYANCES USED FOR THE TRANSPORTATION OF ANIMALS AND POULTRY**

**INSTRUCTIONS IN CIRCULAR 1 FOR INTERPRETING HEALTH REQUIREMENTS**

One should first read and familiarize himself with Section I, II, III, and IV of the Standard Regulation which apply to the issuing of all health certificates. Then he should refer to the Section covering the kind of animal to be shipped, determine its classification and requirements, and refer to the Deviations of the state of destination for any qualifying changes of the Standard Regulation. It is the duty of the certifying veterinarian to determine that the consignor meets the requirements contained in B of Section II and that the shipment is not consigned to a fictitious individual, ranch, or other entity.
A. No animal, including poultry or birds of any species, that is affected with or that has recently been exposed to any infectious, contagious, or communicable disease or that originates from a quarantined area, shall be shipped or in any manner transported or moved into the state until written permission for such entry is first obtained from the livestock sanitary official of the state of destination, except those diseased animals which are approved for interstate shipment under specified restrictions by the Animal Disease Eradication Branch, Agricultural Research Service, U. S. Department of Agriculture.

B. A copy of the official health certificate shall be forwarded immediately by the most rapid means available to the livestock sanitary official of the state of origin for his approval and transmittal.

C. All livestock transported or otherwise moved into the state shall be accompanied by an official health certificate or permit, or both, which must be attached to the waybill or shall be in the possession of the driver of the vehicle or person in charge of the livestock.

D. Requirements for the exhibition of livestock shall be secured by contacting the livestock sanitary official of the state in which the animals are to be exhibited.

E. All animals covered by these regulations originating from public stockyards or which may be assembled at public stockyards or any concentration point from sources of unknown origin shall be required to meet regulations of state of destination before being released.

F. Livestock entering the state without a proper health certificate or a permit, or both when required, shall be held in quarantine at owner's risk and expense until released by the livestock sanitary official.

G. Who may inspect: Accredited, licensed, graduate veterinarians who are approved by the livestock sanitary official of the state of origin and veterinarians in the employ of the Animal Disease Eradication Branch, Agricultural Research Service, United States Department of Agriculture.

H. Who may approve: All health certificates shall bear the approval of the livestock sanitary official of the state of origin.

SECTION II—OFFICIAL HEALTH CERTIFICATE

A. An official health certificate is a legible record covering the requirements of the state of destination, accomplished on an official form of a standard size from the state of origin and approved by the livestock sanitary official of the state of origin, or an equivalent form from the Animal Disease Eradication Branch, Agricultural Research Service, United States Department of Agriculture, and issued by an approved, accredited, licensed, graduate veterinarian.

B. The health certificate shall contain the names and addresses of the consignor and consignee, the origin of the animals, their final destination, and an accurate description or identification of the livestock; also, it shall indicate the health status of the animals involved, including dates and results of required tests and dates of vaccination, if any. All animals shall be consigned to an individual who is a resident
of the state or to a legal entity authorized by law to do business within the state. Health certificates shall be void thirty (30) days after date of inspection and issuance. No health certificate shall be issued unless it can be issued to comply in all respects with requirements of the state of destination, unless specifically otherwise authorized in writing.

C. All brucellosis agglutination tests of animals which are intended for interstate movement shall be made in (1) state or federal laboratories, (2) laboratories approved by the proper livestock sanitary official of the state of origin, or (3) commercial laboratories operated under the supervision of the Animal Disease Eradication Branch, Agricultural Research Service, U. S. Department of Agriculture, and approved by state of origin.

SECTION III—PERMITS

A. Request for permits shall be directed to the chief livestock sanitary official of the state of destination and shall set forth the following information: The names and addresses of the consignor and consignee, number and kind of animals, origin of shipment, proposed date of shipment, method of transportation, proposed destination, approximate date of arrival, and intended purpose of shipment.

B. All animals entering the state under permit shall be consigned to an individual who is a resident of the state or to a legal entity authorized by law to do business within the state.

C. All permits shall be void fifteen (15) days after date of issuance.

SECTION IV—DUTIES OF CARRIERS

A. Owners and operators of railroads, trucks, airplanes, and other conveyances are forbidden to move any livestock, other animals or poultry into or within the state or through the state except in compliance with the provisions set forth in these regulations.

B. All railway cars, trucks, airplanes, and other conveyances used in the transportation of livestock, other animals or poultry shall be maintained in a clean, sanitary condition.

C. Owners and operators of railway cars, trucks, airplanes, and other conveyances that have been used for movement of any livestock, other animals or poultry infected with or exposed to any infectious, contagious, or communicable disease shall be required to have such cars, trucks, airplanes, and other conveyances thoroughly cleaned and disinfected under official supervision before further use is permissible for the transportation of livestock.

D. Owners and operators of railroads, trucks, airplanes, or other conveyances used for the transportation of livestock, other animals or poultry should assure themselves that each consignment is prepared for shipment in keeping with the requirements of the state of destination, and that it is certified on an official health certificate or by a permit issued by the state of destination. Such health certificates and/or permits should be attached to the waybill accompanying the shipment or be in the possession of the attendant in charge of the animals.
LIVESTOCK

(General Rules under Sections I, II, III, and IV apply to all subsequent sections.)

SECTION V—CATTLE

Tuberculosis

A. Cattle for dairy and breeding purposes may enter the state provided:
   1. They originate in an accredited tuberculosis-free herd, the last herd test of which was made within twelve (12) months prior to shipment, or
   2. They have been tested with negative results within thirty (30) days of shipment and originate from unquarantined herds in a modified-accredited tuberculosis-free area.

B. Range and semirange cattle.
   1. Range and semirange cattle of the beef breeds are not required to be tested for tuberculosis provided they originate in a modified-accredited tuberculosis-free area, from a herd or herds not under quarantine and provided further they originate in and are destined to any of the group of states named herein: Arizona, California, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, Oklahoma, Texas, Utah, Washington, and Wyoming (Consult Deviations of state of destination in this issue of Circular 1 as some of the above mentioned states require a permit in addition to a health certificate.)

C. Feeder cattle.
   1. Feeder cattle of the beef breeds which originate in unquarantined herds in modified-accredited tuberculosis-free areas may enter the state without a test for tuberculosis if accompanied by an approved clinical health certificate or permit from state of destination, or both when required. (Consult Deviations of state of destination in this issue of Circular 1 as many states require prior permits in addition to health certificates.) (It is understood that all tuberculosis infected and exposed herds in all states will be quarantined and tested in keeping with approved uniform methods.)

Brucellosis

A. Cattle for dairy and breeding purposes may enter the state provided:
   1. They originate directly from officially certified brucellosis-free herds, or
   2. They have passed a negative agglutination blood test within thirty (30) days of shipment, or
   3. They are cattle of the beef breeds originating directly from negative herds, not under quarantine for brucellosis, in range states in modified-certified brucellosis-free areas, or
   4. They are cattle from modified certified brucellosis-free areas officially vaccinated and under 24 months of age.

B. Feeder cattle of the beef breeds may enter the state without a test for brucellosis provided:
1. They are steers, spayed heifers, or calves of the beef breeds under eight (8) months of age, or
2. They are officially calfhood vaccinated animals under twenty-four (24) months of age and properly identified, or
3. They are cattle of the beef breeds originating directly from negative herds not under quarantine for brucellosis in modified-certified brucellosis-free areas.

**Cattle for Immediate Slaughter**

A. Cattle for immediate slaughter may enter the state without a health certificate or negative test for brucellosis or tuberculosis if:

1. Consigned to a recognized slaughtering center where federal, state or municipal meat inspection is maintained (except brucellosis and tuberculosis reactors, which must be shipped only to plants operating under federal inspection and be accompanied by an official Form T. E. 27), and shall be considered under quarantine until slaughtered. Such animals shall not be diverted without an official permit from the livestock sanitary official of the state of destination; or
2. Shipped to a stockyard where federal inspection is maintained.

**Scabies**

No cattle affected with or exposed to scabies shall be shipped, trailed, driven, or otherwise transported or moved into another state for any purpose.

**SECTION VI—DOGS**

A. All dogs to be moved or transported into the state for any purpose shall be admitted only when accompanied by an official health certificate completed by an approved, accredited, licensed, graduate veterinarian of the state of origin, who shall certify that the animals are free from all infectious and contagious diseases or known exposure thereto, did not originate within an area under quarantine for rabies or an area where rabies is known to exist even though not quarantined, have not been exposed to rabies, and have been officially vaccinated against rabies and identified by vaccination certificates and tags bearing serial numbers not more than twelve (12) months prior to shipment.

B. Dogs originating in areas where rabies exists may be brought into the state only if a written permit is obtained first from the livestock sanitary official of the state of destination.

**SECTION VII—GOATS**

Goats for dairy and breeding purposes may enter the state provided they are accompanied by a health certificate showing they come from a certified brucellosis-free herd, are negative to the agglutination test for brucellosis within thirty (30) days of date of entry, and are clinically free from all other infectious and communicable diseases. The health certificate shall contain a full description of each animal, giving age, color and markings.
Goats for immediate slaughter: Apparently healthy goats may be moved into the state when consigned directly to a recognized public stockyard or a slaughtering establishment or slaughtering center that is approved and designated by the Animal Disease Eradication Branch, Agricultural Research Service, U. S. Department of Agriculture, and the livestock sanitary official of the state of destination.

SECTION VIII—HORSES, MULES, AND ASSES

These animals may be transported or moved into the state when accompanied by an official health certificate.

SECTION IX—POULTRY

A. Chickens, turkeys or other poultry over five (5) months of age intended for breeding purposes shall not be imported into the state unless they have passed a negative agglutination test for pullorum disease in which no reactors were disclosed (testing must be conducted under the supervision of a state livestock sanitary authority within thirty (30) days preceding date of importation), or have originated from flocks authoratively participating in such pullorum control and eradication phase of the National Poultry Improvement Plan or National Turkey Improvement Plan as may be adopted in the state of origin, which shall be pullorum passed or better.

B. All poultry under five (5) months of age, including baby chicks, started chicks, turkey poult:s, other newly hatched domestic poultry, except those intended for immediate slaughter, and hatching eggs shipped or otherwise brought into or offered for sale in the state shall have originated in flocks that meet the pullorum requirements of the National Poultry Improvement Plan or the National Turkey Improvement Plan, and shall have originated from a hatchery or premises operating under the supervision of the poultry disease control authority of the state of origin, and their pullorum classification shall be pullorum passed or better. Each 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 must be approved by the official state agency or the livestock sanitary official of the state of origin.

SECTION X—SHEEP

A. General. All sheep entering the state for purposes other than immediate slaughter shall be accompanied by an official health certificate stating they are free from scabies, lice, foot rot, scrapie and all other infectious or communicable diseases, and have not been exposed to such diseases.

B. Scabies. If the sheep originate from a state known to have scabies, they shall be accompanied by a prior permit from the state of destination, which shall be attached to the health certificate. The health certificate shall show the sheep have been dipped once in a wettable benzene hexachloride (BHC) or lindane solution containing gamma isomer concentrate of not less than 0.06 per cent within ten (10) days prior to date of importation, or to have been dipped twice in lime
and sulphur with the dippings ten (10) to fourteen (14) days apart and the last
dipping within ten (10) days prior to date of importation. All such dippings shall
be under state or federal supervision.

C. Feeder lambs. Lambs may be shipped or moved into the state for feeding
purposes provided they are accompanied by an official health certificate indicating
they originated from a state free of scabies and are free from infectious diseases or
recent exposure thereto.

D. Sheep shipped from or handled in or through a public saleyard or auction
yard shall not be moved in any manner into the state unless on special permit
first obtained in writing. Such sheep shall be dipped as prescribed in Paragraph B
above before being permitted to enter the state.

E. Sheep shipped or transported into the state by railroads, trucks, airplanes,
or other conveyances shall be shipped in cleaned and disinfected railroad cars,
trucks, airplanes, and crates if by express. (Consult Deviations of state of destina-
tion in this issue of Circular 1 as many states require a permit in addition to a
health certificate.)

SECTION XI—SWINE

A. General. All swine transported or moved into the state shall be accompanied
by a health certificate showing that the swine have been given a veterinary inspec-
tion just prior to shipment and that the swine have not been fed raw garbage and
have not been affected with or exposed to vesicular exanthema or other contagi-
ous or communicable diseases.

B. Feeder swine. Swine for feeding purposes may enter the state provided they
are accompanied by the health certificate as required in Paragraph A [also shows
that] such swine have been officially vaccinated with anti-hog cholera serum and
virus with approved dosage of each, which dosage shall be recorded on the health
certificate, not less than thirty (30) days prior to date of entry, or a modified hog
cholera virus with anti-hog cholera serum as recommended by the biological manu-
facturer not less than fifteen (15) days prior to date of entry, or serum alone just
prior to shipment.

C. Breeding swine. Swine for breeding purposes may enter the state provided
they comply with Paragraphs A and B and in addition thereto originated in a
brucellosis-free herd and are negative to the brucellosis agglutination test within
thirty (30) days of date of entry.

"The requirements in the Standard Regulation qualify most shipments for
interstate movement. However, the amended requirements of the state of des-
tination must be consulted and complied with in every respect before health
certificates are issued."

SUMMARY OF STATE REGULATIONS GOVERNING THE INTERSTATE MOVEMENT
OF CATTLE

The Summary, covering the admittance of cattle into the various states, is set
up so that an X in the column under the name of a state opposite the designated
qualifications indicates they are acceptable; those which are not so marked with
## SUMMARY OF STATE REGULATIONS GOVERNING THE INTERSTATE MOVEMENT OF CATTLE

**Tuberculosis - Breeding Cattle**
1. Ewes bred to non-AFZ/BSE-1 origin.
2. Ewes bred within 12 months.
3. Ewes bred within MO-AFCZ area. Individual test if not bred within 12 months.
4. Ewes bred to non-AFZ/BSE-1 origin.

### Feeder Steers
1. Official health certificate.
2. Prior permit required.
3. Prior permit only.

### Feeder Cattle of the Beef Breed
1. Official health certificate.
2. Prior permit not required if from a non-AFZ/BSE-1 area.
3. Prior permit not required if from a non-AFZ/BSE-1 area.
4. Prior permit required if under 90 days of age.

### Explanation of Letters Used
- A: Prior permits required
- B: Acceptable if off vac
- C: Acceptable if off vac & under 18 mos. of age
- D: Acceptable if off vac & under 30 mos. of age
- E: Subject to quarantine at destination
- F: No restrictions
- G: Subject retest for T.B. or BSE or both.

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**Table:**

| State | AL | CA | CO | CT | DC | DE | FL | GA | HI | IA | ID | IL | IN | KS | KY | LA | ME | MI | MN | MO | MS | MT | NE | NV | NC | ND | OH | OK | OR | PA | RI | SC | SD | TN | TX | UT | VA | VT | WA | WI | WV | WY |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Note: | X-cattle of the class marked with an X is acceptable to the state of destination.

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**Prepared by:** U.S. Livestock Sanitary Assoc., 1956-4
**Expiration Date:** 4-1-56.
an X are not acceptable. Therefore, reference should be made to the Deviations in Circular 1 before completing a health certificate.

For example—if you wish to ship cattle into Montana you should familiarize yourself with the various classes of cattle covered in the Summary and determine the class of cattle you are required to clear. You will find under the state designated as "Montana" an X following each designation which is acceptable. Then you should consult Circular 1 and check the Deviations under Montana. You will note that if you are shipping strictly range cows from one of the Western states from a herd not under quarantine for tuberculosis such range cattle can come into Montana without a TB test. Also, read the explanations, a, b, c, d, e, which may be found with an X, which modifies the general acceptability.

However, sheep entering Montana, in addition to complying with the requirements of the Standard Regulation, will be quarantined upon arrival for ninety (90) days and until inspected and released by a representative of the Livestock Sanitary Board, which is specified under Deviations for Montana.

Whenever state regulations do not coincide with those of the Standard Regulation then that state will set forth its deviations, which will point out the requirements to enter such state.

Your committee recommends:

1. The adoption and printing of the proposed Standard Regulation as set forth in this report in the front of Circular 1 unless a new report is approved before the next printing of Circular 1.

2. That the new committee be composed of veterinary members from the east, southeast, south, southwest, central and western states, the Animal Disease Eradication Branch, Agricultural Research Service, United States Department of Agriculture, and livestock men or others who are actively interested in this problem.

3. That meetings of representatives from the various regions be held between national meetings and their suggestions forwarded to the Chairman.
DISCUSSION OF THE REPORT OF THE COMMITTEE ON LAWS AND REGULATIONS

DR. RALPH A. WEST: Mr. President, I regret to take the time, but there is a matter in this report which has been discussed and rediscussed and is not consistent with our action and that is a standard regulation to recommend or permit the movement of vaccinates without a test up until thirty months of age. That is not consistent with either the action taken last year, the action of the Committee on Brucellosis, or the general understanding that has been arrived at over the last few years.

There has been nothing, to my knowledge, nor anything disclosed to the Committee on Brucellosis, to indicate there has been any change or any evidence presented to authorize or to recommend an extension of time following vaccination within which cattle should be moved interstate.

I certainly want to go on record to that extent, and in conformity with what was done a year ago I will again move that the Committee on Laws and Regulations be requested to amend their report to change the figure of thirty months to twenty-four months in the section referred to.

PRESIDENT GREEN: Dr. West, I assure you that you as well as any other member of the Executive Committee will be heard from, but I believe you are out of order at this time. This report will be submitted to the Executive Committee, at which time you or any other member of the Executive Committee may file an objection.

DR. HENDERSHOTT: Mr. President, I would like to second Dr. West's motion. I don't think you are entirely correct relative to the motion being out of order.

These committee reports, when given, are to be open for discussion and are eligible for discussion by the membership at large of this Association so that they might have an opportunity to recommend to the committee any changes that they see fit to make.

While I am on my feet, may I say I think it is an oversight on the part of the Committee, in dealing with the health requirements of swine in interstate commerce, to use the statement that no garbage-fed swine can move in interstate commerce. I don't believe the Committee really meant that. I think you should insert before the word "garbage" the word "raw" so that no raw-garbage-fed swine can move in interstate commerce. I ask that the Committee seriously consider that change.

PRESIDENT GREEN: If I am wrong in my interpretation of the procedure I beg the pardon of this Association.

DR. WEST: I made a motion, Mr. President, that this Association request the Committee on Laws and Regulations to amend their report by changing the figure of thirty months to twenty-four months where they refer to the movement of animals vaccinated against brucellosis.

DR. HENDERSHOTT: I second the motion, Mr. President.

[The motion was put to a vote and was carried unanimously.]

PRESIDENT GREEN: Is there anything else claiming the attention of this Association before we recess for lunch? If not, we are recessed.

[The meeting recessed at 12:20 p.m.]
During the past year, the Federal government has acted upon a number of important measures of interest to this Association. As of January 1, 1954, the United States Department of Agriculture was reorganized as authorized by the previous Congress, abolishing the Bureau of Animal Industry which had existed since 1884. The duties formerly carried on by the Bureau have now been separated so that regulatory and enforcement duties are completely separated from research activities. Only time will tell as to the wisdom and effectiveness of this change. The details of the reorganization have been published and are available to all concerned, and it is not necessary to discuss them here.

Early in 1954, the United States Secretary of Agriculture, Ezra T. Benson, submitted his budget for the 1955 fiscal year beginning July 1, 1954. No funds were requested in this budget for the payment of Federal indemnity for cattle condemned for tuberculosis or brucellosis. The situation at that time was as follows:

(1) The amount of money requested for indemnity for the 1954 fiscal year, had been cut by Congress in the amount of $500,000.00 as an economic measure, only $640,000.00 being appropriated for that year.

(2) Because of this shortage of funds, the Bureau of Animal Industry had found it necessary to amend their regulations, reducing Federal indemnity payments for brucellosis to a maximum of $9.00 for each grade animal condemned, and $18.00 for each purebred animal. This action became effective September 23, 1953.

(3) Even at this reduced figure, Federal funds for the payment of indemnity were practically exhausted by January 1, 1954, and the allotments to some states completely so.

(4) Because of different state laws, the effect of this depletion of Federal funds, differed widely in different states, but most states were able to continue, if only on a limited scale under the revised regulations.

The threat imposed by the omission of any provision for Federal payment after July 1, 1954, was extremely serious since no previous notice of intent had been given, and since the action was taken while most of the state legislatures were not in session, and would not be for another year. In previous sessions, state appropriations had been made on the supposition that Federal payments would continue as they had for many years in the past. If federal appropriations were made in accordance with the budget submitted, brucellosis and tuberculosis control programs would be seriously handicapped, and under many state laws, would require complete cessation of all work in brucellosis and tuberculosis control, at least until the state legislatures could meet and amend their state laws.

This situation was called to the attention of all regulatory officials by our Secretary, Dr. Ralph Hendershott, and many states immediately protested to their
Congressmen. President Green called a meeting of the Executive Committee of this Association in Chicago in March, 1954, where resolutions urging the appropriation of at least $1,000,000.00 to cover Federal indemnity payments were adopted. The Sub-Committee presided over by Representative H. Carl Anderson of Minnesota, amended the Appropriation Bill to include 1,000,000.00 for the United States Department of Agriculture for the payment of brucellosis and tuberculosis indemnities. This Bill was slightly amended by the whole House Committee and the Senate but the final appropriation for Federal indemnity for tuberculosis and brucellosis for the present fiscal year was $873,500.00.

The reports of the Committee proceedings when hearings were held on the Department of Agriculture's budget, indicated clearly it was the intent of Congress, the Federal Government should continue to participate with the states in all phases of the programs for the eradication of tuberculosis and brucellosis.

On June 24, 1954, Congressman Clifford Hope of Kansas, introduced the so-called “Farm Bill”, (H.R. 9680). Section 324, sub-title E of this Bill, included authorization for the Secretary of Agriculture to transfer $15,000,000.00 annually for two years, from the Commodity Credit Corporation funds to the appropriation item “Plant and Animal Disease and Pest Control” in the Department of Agriculture Appropriation Act in 1955, “for the purpose of increasing not to exceed $50.00 per head of cattle, the amount of the indemnities paid by the Federal Government for cattle destroyed because of brucellosis in connection with cooperative control and eradication programs for such disease in cattle entered into by the Secretary under the authority of the Act of May 29, 1884, as amended for the purpose of increasing the number of such indemnities, and for the purpose of defraying any additional administrative expenses in connection therewith.” This section remained intact when the Bill was passed by the House. It was not, however, included in the Senate Bill. In communicating with key senators, the Chairman of your Committee was informed it was the intent of those interested in this measure, to substitute the House Bill with the provisions above noted intact when the two Bills went to conference. This was done and on the last day of the session, the Bill was passed by both the House and Senate, including the provision for the transfer of funds.

As you know, the Secretary of Agriculture has recently transferred $10,000,000.00 of the $15,000,000.00 authorized for the present fiscal year, and steps are now in progress to expedite the brucellosis control program to the fullest extent possible with these funds.

On July 1, your Committee Chairman was notified by Secretary Hendershott that Bills to amend the Organic Act of the Virgin Islands had been introduced in the House and Senate. These Bills (H.R. 5181 and S. 3378) included amendments to the laws governing the importation of livestock and poultry into the Virgin Islands and restricted the authority of the Secretary of Agriculture to regulate the importation of poultry into said islands. It was evidently the intent of the authors of these Bills to make it possible to move livestock and poultry from the British Virgin Islands into the Virgin Islands of the United States for slaughter, but as the Bills were worded, there is no requirement that such cattle shall be used only for immediate slaughter, and they also would permit the introduction of cattle from tick infested areas other than the British Virgin Islands. Also both Bills included a
provision prohibiting the Secretary of Agriculture from regulating the importation of poultry into the Virgin Islands of the United States.

These amendments to the Organic Act of the Virgin Islands constitute a serious loop-hole in our defense against the introduction of diseases of domestic animals and poultry into the United States and jeopardize the livestock industry of the entire country.

At the time we learned of the provisions of these Bills, they had both been passed and were in conference committee. We were informed it was too late to amend the provisions referred to at that time, since they were identical in both Bills. The conference report was adopted and the Bills repassed and are now law.

On July 24, Senator Aikin introduced a Bill (S. 3800) to amend this law in accordance with recommendations made by the United States Department of Agriculture and supported by this Association through its Secretary and Legislative Committee. Senator Aikin’s Bill provided that the importation of cattle from tick infested areas into the Virgin Islands would be restricted to such cattle originating in the British Virgin Islands, and further provided that such cattle would be admitted into the Virgin Islands of the United States for slaughter only. The Bill also deleted the section prohibiting the Secretary of Agriculture from regulating the importation of poultry into the Virgin Islands.

This Bill passed the Senate without opposition and your Committee Chairman is informed no opposition to the Bill developed in the House of Representatives, but Congress adjourned before it could be acted upon. We are further informed, the measure will be again introduced in the new Congress when it meets in January.

It is the understanding of your Committee that state legislation has been enacted in some states and is contemplated in others particularly with reference to authorization of state disease regulatory agencies to more effectively control diseases of domestic animals and particularly brucellosis. Your Committee urges that State Regulatory Officials notify the Chairman of the Committee on Legislation of this Association when such legislation is enacted. It is believed that if he has access to such information, the reports of this Committee will be of greater value.
REPORT OF THE COMMITTEE ON RESOLUTIONS

T. B. COLWER, Atlanta, Georgia, *Chairman*; W. B. EARL, Reno, Nevada; K. J. PETERSON, Salem, Oregon; M. N. RIEMENSCHNEIDER, Denver, Colorado; R. S. ROBINSON, Pierre, South Dakota; B. T. SIMMS, Sr., Washington, D. C.

I

That we extend our thanks to the employees of the Hotel Fontenelle for the excellent services rendered the Association throughout the meeting and our appreciation of the many courtesies shown the members, all of which have contributed much to the pleasure of attendance.

II

That the United States Livestock Sanitary Association convey its sincere thanks and appreciation to each speaker on the program, and to each member of the several committees, for their services in the preparation and presentation of the program.

III

That we particularly extend our thanks and appreciation to Dr. J. L. George, Earle S. Reed, and the committee on arrangements for the excellent preparations made for this meeting, and the entertainment of the ladies and the many kindnesses and demonstrations of hospitality.

IV

That we extend our thanks and appreciation to Harry B. Coffee and the Omaha Livestock Exchange for their generosity and hospitality extended to the members.

V

That we express our sincere thanks and commend our Secretary, Dr. R. A. Hendershott for his excellent and untiring efforts in behalf of the Association.

RESOLUTIONS PERTAINING TO IMPORTATIONS OF ANIMALS

I

WHEREAS, the Carolaize cattle smuggled into the United States from an area in Mexico where foot and mouth disease has been very prevalent, and

WHEREAS, it is evident from the reoccurrence of foot and mouth disease in Mexico that the disease may remain dormant for an indefinite period in an area where there are recovered animals, then suddenly and unexpectedly manifest itself, and

WHEREAS, the presence of the Carolaize cattle in Louisiana constitutes a potential threat to the entire livestock industry of the nation, and

WHEREAS, the precedent established by this case will definitely affect the future enforcement of livestock import regulations, designed to protect the livestock industry; therefore be it

RESOLVED, that the United States Livestock Sanitary Association re-affirms its
position in this matter and urges the United States Treasury Department and the United States Department of Agriculture to take immediate action to remove this threat to the livestock industry by either the return of the Carolaisecattle to Mexico or their immediate destruction, and be it

FURTHER RESOLVED that copies of this resolution be forwarded to livestock and other interested organizations throughout the United States with the request that they give serious consideration to this problem.

II

WHEREAS, it is necessary to protect United States livestock from devastating exotic diseases such as foot and mouth disease which is enzootic in most livestock producing nations of the world, be it

RESOLVED, this this Association requests the United States Department of Agriculture to sponsor laws and promulgate regulations which will prevent the importation of ruminants or swine into the United States that have recovered from, been exposed to, or vaccinated against foot and mouth disease or any other exotic disease, and be it

FURTHER RESOLVED, that copies of this resolution be forwarded to livestock and other interested organizations throughout the United States with the request that they give serious consideration to this problem.

RESOLUTIONS PERTAINING TO SWINE DISEASE RESEARCH

WHEREAS, our American swine industry is a multibillion dollar industry, and
WHEREAS, the swine raisers, veterinarians, livestock sanitarians and related industries realize the terrific toll levied annually by swine diseases and parasites, and
WHEREAS, it is apparent that a reduction of such losses can only be attained on the basis of research,

THEREFORE, BE IT RESOLVED, that the United States Livestock Sanitary Association urge the Agricultural Research Service of the United States Department of Agriculture to rehabilitate and expand the historic Federal Hog Cholera Experiment Station near Ames, Iowa, into a fully adequate and technically staffed swine disease research center.

RESOLUTIONS PERTAINING TO SHEEP SCABIES

WHEREAS, many states of the nation have eradicated sheep scabies, and,
WHEREAS, such eradication programs have been accomplished at great expense and effort on the part of the sheep industry, and
WHEREAS, there is now available a highly effective miticidal agent—benzene Hexachloride or lindane, and
WHEREAS, there continues to exist reservoirs of sheep scabies in several states, chiefly east of the Missouri River, and
WHEREAS, these reservoirs of infestations continue to be a threat to the sheep industry, and
WHEREAS, a constant vigilance must be maintained to prevent the reinfestation of the flocks of various states, and
WHEREAS, constant vigilance results in restrictions in commerce which are costly to industry, and

WHEREAS, even with the exercise of constant vigilance, infestations of sheep of the states continue to occur periodically incurring further restrictive measures and expense.

THEREFORE, BE IT RESOLVED, that the United States Livestock Sanitary Association urge and request the Honorable Ezra Taft Benson, Secretary of the United States Department of Agriculture, to take a firm stand to effect a complete eradication of sheep scabies immediately.

RESOLUTIONS PERTAINING TO PARASITE CONTROL AND RESEARCH

WHEREAS, the United States Department of Agriculture has been reorganized along functional lines with separation of research and regulatory work, and

WHEREAS, activities of the Agricultural Research Service have been divided on a functional basis into such units as Crops Research, Crops Regulatory Programs, Livestock Research, and Livestock Regulatory Programs, and

WHEREAS, it is the announced intention to bring together in each of these units all activities in its respective field, and

WHEREAS, this has been done in the different units responsible for Crops Regulatory Programs and Livestock Regulatory Programs, and

WHEREAS, research with insects and other arthropods affecting plants has been allocated to the Crops Research unit, thus following the announced functional plan of reorganization, and

WHEREAS, most of the research with insects and other arthropods affecting livestock and poultry is presently assigned to the Crops Research unit, and

WHEREAS, all other research with animal diseases including that with protozoan, helminth, and some arthropod parasites has been assigned to the Livestock Research unit, and

WHEREAS, the allocation of most of the research with insects and other arthropods affecting livestock and poultry to the Crops Research unit is resulting in a division of research along functional lines which is confusing and not conducive to the development of a broad, overall, closely integrated program of research in the field of animal diseases, and

WHEREAS, this Association believes very strongly that assignment of all research with livestock and poultry diseases, including work with insects and other arthropods, to the Livestock Research unit of the Agricultural Research Service will strengthen and unify this work and bring the organization of this unit in line with the announced plan for reorganization of the Department of Agriculture, therefore

BE IT RESOLVED, that the United States Livestock Sanitary Association recommends and requests that all research work with diseases and parasites of livestock and poultry, including that with insects and other arthropods which affect domesticated animals, be assigned to the Animal Disease and Livestock Parasite Research Branch of the Agricultural Research Service.
REPORT OF COMMITTEE ON STOCKYARDS, MARKETS AND TRANSPORTATION

A. Z. Baker, Cleveland, Ohio, Chairman; T. W. Cole, Washington, D. C.; R. Cuff, Kansas City, Kansas; R. A. Hendershot, Trenton, New Jersey; R. H. Lay, Winnipeg, Canada; E. Miller, Iowa City, Iowa; E. Reed, Omaha, Nebraska; J. G. Schaefer, St. Louis, Illinois; G. Silknitter, Sioux City, Iowa; S. Sprunger, Kidron, Ohio.

The members of the Committee on Stockyards, Markets and Transportation and others engaged in providing and furnishing facilities, vehicles and services used in the handling, marketing and transportation of livestock, are pleased to have a part in your program and an opportunity to hear the many excellent papers and discussions relating to livestock diseases and their control and eradication.

Much of what is heard is a language strange to stockyard operation and transportation but there is no escaping the conviction that transportation agencies and those who provide and operate concentration yards, buying stations, local markets and stockyards, not only contribute to the development and spread of livestock diseases, but are, in fact, the fields in which sanitary and control authorities must wage battle to control, prevent the spread of, and eradicate communicable diseases.

The Committee notes with much satisfaction the improved conditions of livestock health in North America compared with a year ago and attributes much of the improvement to realistic and understanding cooperation between the regulatory authorities of the Federal governments and of the several states with those engaged in the production, handling, marketing and transportation of livestock. Some of that understanding and cooperation has no doubt resulted from meetings of this Association, but much of it has been the result of a recognition on the part of regulatory authorities of the practical problems of production, marketing and transportation and a willingness to modify regulations and instructions to meet operating situations so far as possible within the requirements of reasonable control and eradication problems. Believing that understanding and cooperation between the regulators and the regulated will in the long run produce the most results at the least cost to all concerned, the committee makes the

1st Recommendation, that regulatory authorities of the Federal and State governments be urged to consult with representatives of producers, handlers, marketers and carriers of livestock in respect to the formulation, modification and enforcement of regulations and instructions for the control and eradication of livestock diseases for the purpose of making such regulations and instructions and their enforcement realistic, practical and enforceable; and that those engaged in providing facilities, vehicles, equipment and services in connection with the handling, marketing and transportation of livestock be encouraged to cooperate with regulatory authorities to the fullest reasonable extent in the control and prevention of the spread of livestock diseases.

It is inevitable, with the many different authorities charged with, or authorized to, regulate and control the movement of livestock within and between states, and
with the many agents of these authorities to whom enforcement of regulations is delegated, that there should be a wide variety of regulations, instructions and enforcements, aimed at the same or similar conditions. Some variation is justified and desirable because of different conditions but it appears that wide variations create misunderstanding, confusion and inefficient and discriminatory enforcement by officials, and ineffective compliance by producers, carriers and handlers. There is some excuse for a different approach to regulation and enforcement in the different season of the year and in the different latitudes but there is no justification for the very lax attitude evidenced by a concern only for the issuance or receipt of a certificate, or for the very strict attitude evidenced by an effort to apply every rule in the book in all cases. The Committee believes that there should be more uniformity of regulations and instructions and better understanding on the part of field agents and veterinarians with more uniformity of enforcement practices within the reasonable limits of local conditions; and makes the

2nd RECOMMENDATION, that the regulations and instructions of the various regulatory authorities of the Federal and State governments pertaining to the transportation, handling and marketing of livestock within and between the several states, be compiled and given wide distribution for the purpose of promoting better understanding and enforcement of, and compliance with, existing regulations and instructions and of encouraging the development of more uniformity of regulations, instructions and practices in the future.

The Committee is concerned with the inclination of many producers and some veterinarians to hurry livestock to market whenever there is an indication of diseased conditions, thereby endangering premises along the route to market, contamination of vehicles of transportation and stockyards and market facilities and making likely the widespread of disease before its detection and eradication. The Committee therefore makes the

3rd RECOMMENDATION, that livestock found to be, or suspected of being, infected with or exposed to communicable livestock diseases be quarantined on the premises until such time as the conditions are corrected and removal of quarantine may be reasonably and safely made.

The Committee notes with satisfaction the compliance on the part of most carriers of livestock with the regulations and instructions requiring the cleaning and disinfecting of facilities, equipment and vehicles, but is concerned with the failure of many carriers to reasonably comply with such regulations. Some of the failure is, no doubt, attributable to the lack of State regulations or the ineffective enforcement of existing regulations and to the limited operations of many of the carriers who may not be familiar with requirements. The Committee believes that control and eradication of livestock diseases require all transportation agencies to observe reasonable practices in respect to the cleaning and disinfecting of shipping facilities, equipment, and vehicles of transportation. The Committee makes the

4th RECOMMENDATION, that the several state regulatory agencies prescribe regulations or issue instructions relating to the transportation of livestock and require the cleaning and disinfecting of all facilities, equipment and vehicles and other conveyances used in transporting livestock similar to the regulations, instructions and requirements of the Federal government.
The Committee recognized that places where livestock is received, held or kept for shipment or sale, including concentration yards, buying stations, auctions, stockyards, and other market places, constitute a major hazard in the control, prevention and eradication of livestock diseases. These are the places to which most of the livestock from all of the farms and the ranches ultimately go, and from which the livestock again moves to many farms and ranches throughout the country. Potentially, they may receive diseased or exposed animals from everywhere and distribute them everywhere.

Most of these assembly and distribution places maintain satisfactory and sanitary conditions and observe effective practices prescribed or enforced by the Federal and State agencies. Unfortunately, there appears to be many which, because of location, volume, lack of regulations or supervision, do not maintain safe, sanitary conditions or observe reasonable practices in regard to cleaning and disinfecting. The Committee believes that the control and spread of livestock diseases requires all places used for the assembly and distribution of livestock to be maintained and kept in a satisfactory sanitary condition and regularly cleaned and disinfected.

The Committee makes the 5th RECOMMENDATION, that the various Federal and State regulatory authorities be requested to establish and enforce reasonable regulations and practices requiring all places where livestock is received, held or kept for sale or shipment, within or between states, be constructed, maintained and kept in a safe sanitary condition and cleaned and disinfected under the supervision and at the direction of the authority so as to control and prevent the spread of communicable livestock diseases.

The Committee notes the prevalence from time to time of the livestock disease of scabies in sheep and cattle and the effect of quarantines and embargoes on the movement and marketing of such livestock from wide areas in which such diseases appear. The Committee makes the 6th RECOMMENDATION, that the authorities of the Federal and State government take every reasonable step to expedite the eradication of the outbreaks of scabies whenever they appear and that they develop some cooperative plan whereby the quarantined areas may be reasonably defined and embargoes be similarly limited, with information regarding quarantines and embargoes and their removals given prompt and adequate publicity in order that the transportation and marketing may not be unnecessarily impeded.

The Committee notes with approval the activities of the several states aimed at the eradication of brucellosis but is concerned with the effect of the various regulations and practices upon the transportation, marketing and handling of animals which have been or may be subject to treatment. The Committee is particularly concerned with the delays and interference with the movement within and between states in connection with the sale of young female cattle. It notes the proposals of the states of Kansas, Missouri and Oklahoma to identify female calves officially vaccinated for brucellosis by distinctive orange colored numbered ear-tags which are easily discernable and recognizable and which facilitates and expedites the movement in transportation, handling and sale. The Committee makes the 7th RECOMMENDATION, that all female calves and heifers under 24 months of
age officially vaccinated in calfhood for brucellosis be identified by distinctive easily recognizable ear-tags or other marks to facilitate and expedite their movement within and between the several states and in the handling and sale at stockyards and other markets.

The committee notes with great satisfaction the success achieved in the control and eradication of the swine disease vesicular exanthema which in large part resulted from the understanding cooperation of the Federal and State authorities with those engaged in feeding, handling and transporting swine. Carriers, and stockyards in Interstate Commerce have maintained facilities, equipment and vehicles in sanitary conditions and have cleaned and disinfected such facilities, equipment and vehicles under prescribed regulations and instructions or whenever the need appeared. The Committee believes conditions have so far improved that the regulations and instructions pertaining to the cleaning and disinfecting of facilities, equipment and vehicles might safely be modified to relieve the cost burden and expedite the movement of swine. The Committee makes the

8th RECOMMENDATION, that the regulation and instruction of the Federal and State authorities relative to the cleaning and disinfecting of facilities, equipment and vehicles used in the movement of swine be further modified at this time and from time to time as conditions warrant, and particularly at this time and throughout the winter season that the disinfecting of facilities, equipment and vehicles be omitted except in cases where vesicular exanthema is found or suspected to exist.

The Committee appreciates this opportunity to make specific recommendations and hopes that it will be able to assist the program of the Association by considering and making recommendations on other matters referred to it.
A COMPARATIVE EVALUATION OF TEN ANTIBIOTICS IN EXPERIMENTAL INFECTIONS WITH ELEVEN HUMAN AND VETERINARY PATHOGENS*

J. S. KISER, PH.D. AND G. C. de MELLO, B.A.

Chemical and Biological Research Section, Lederle Laboratories Division, American Cyanamid Company, Pearl River, New York

We have compared Aureomycin† (chlortetracycline), Terramycin‡ (oxytetracycline), Achromycin† (tetracycline), chloromycetin, streptomycin, neomycin, penicillin, erythromycin, Magnamycin‡ (carbomycin) and viomycin in experimental infections with Streptococcus pyogenes, Staphylococcus aureus, Diplococcus pneumoniae, Listeria monocytogenes, which causes an infection in the brain of cattle and sheep, Erysipelothrix rhusiopathiae which causes erysipelas of swine and turkeys, Bacillus anthracis, Pasteurella multocida the causative agent in shipping fever, Klebsiella pneumoniae type A which causes a pneumonia in man and type B which may induce a septicemia in mares and foals, Salmonella gallinarum which causes fowl typhoid and with Mycobacterium tuberculosis. The test methods used for most of these experimental infections have been described previously (1, 2, 3) so will not be repeated here.

The methods for the B. anthracis, L. monocytogenes, E. rhusiopathiae and K. pneumoniae type A infections have not been previously described so will be briefly outlined at this point:

B. anthracis strain 20S

Groups of ten albino mice weighing 18 ± 2 gm. were infected subcutaneously with 0.5 ml. of a spore suspension. This volume contained about $3.0 \times 10^3$ anthrax spores or about one thousand lethal doses (LD100). The mice were treated twice daily with 0.5 ml. of drug solution injected intra-abdominally, starting one hour after infection, and continued for four days for a total of eight doses. Fifty per cent of the non-treated control mice are usually dead in 40 hours.

L. monocytogenes strain LM-2035

Groups of ten albino mice weighing 18 ± 2 gms. were infected intraperitoneally with 0.5 ml. of a $10^{-1}$ peptone water dilution of a brain heart-infusion broth culture incubated 18-24 hours at 37° C. This infecting dose represented about a thousand LD100 and contained about $1.0 \times 10^8$ organisms. Treatment consisted for four intra-abdominal injections at 1, 24, 48 and 72 hours with a 0.5 ml. volume of drug solution. The time of death of fifty per cent of the non-treated control mice is 40 hours.

* Published with the approval of Dr. J. H. Williams, Director of Chemical and Biological research.
† Trade-Mark of American Cyanamid Company.
‡ Trade-Mark of Chas. Pfizer & Co., Inc.
Groups of ten albino mice weighing 18 ± 2 gm. were infected subcutaneously with 0.5 ml. of a 10⁻⁸ peptone water dilution of a yeast-bile broth culture which had been incubated 18–24 hours at 37°C. This represented about ten thousand LD₁₀₀₀ and about 1.0 × 10⁶ organisms. Treatment was the same as for the L. monocyctogenes infection. The time of death of fifty per cent of the non-treated controls was 72 hours.

The results of these tests are shown in a series of bar-graphs in which the entire series of antibiotics may be compared, on a weight basis, for their activity against a single infection. This will be followed by another set of graphs which shows the spectrum of activity of each individual antibiotic against the whole series of infections.

The bars indicate the dose, in milligrams per kilogram, required to give 80–100 per cent protection, except in the case of the S. gallinarum and M. tuberculosis infections. Since we do not know of any drug which will completely cure these infections, that is, which will abolish the carrier state, we use prolongation of survival time as our criterion of activity and the bars indicate the minimum dose required for a significant prolongation of survival time. The bars with open ends indicate that at the dose shown some protection was afforded but that it did not reach the 80 per cent level. Where the bar is marked “no activity” the antibiotic failed to save any animals but there may have been some prolongation of survival time. It is important to note that the smaller the dose required to control the infection the shorter the bar and that therefore short bars indicate high activity and the long bars indicate low activity.

The doses of antibiotic required to control these severe experimental infections are, of course, far greater than those required to control field infections but we do believe that the results of these experiments reflect quite accurately the relative effectiveness of the various antibiotics in each infection.

Graph 1 gives the activity of the ten antibiotics against the Streptococcus pyogenes infection. On a weight basis penicillin is still the most effective antibiotic against this organism. As shown in the graph, 80–100 per cent protection was afforded by three doses of the antibiotic at the 0.5 mg./kg. level (840 units/kg.). Ten to 20 mg./kg. doses of Aureomycin, Achromycin and Terramycin were required for equivalent protection.

Graph 2 lists the effect of the antibiotics against Staphylococcus aureus. This is, of course, a more severe infection but it is readily controlled by five doses of 10–20 mg./kg. each of the tetracyclines or penicillin, and, at a somewhat higher dosage with streptomycin or neomycin.

The activity of the antibiotics against Diplococcus pneumoniae is given in Graph 3. Again the tetracyclines and penicillin are highly effective as is erythromycin. Streptomycin requires a higher dosage. Three doses are given, as with S. pyogenes.

Listeria monocyctogenes, which causes essentially an encephalitis, is not easily controlled as shown in Graph 4. The antibiotic must penetrate quickly and in good concentration into the cerebrospinal fluid. Aureomycin and Achromycin do that very well but even so four doses of antibiotic are needed in this test.
Graph 1
Doses of Various Antibiotics to give 80-100% Protection against *Streptococcus pyogenes* Infection

- Aureomycin
- Achromycin
- Terramycin
- Chloromycetin
- Streptomycin
- Neomycin
- Penicillin
- Erythromycin
- Magnamycin
- Viomycin

Graph 2
Dose of Various Antibiotics to give 80-100% Protection against *Staphylococcus aureus* Infection

- Aureomycin
- Achromycin
- Terramycin
- Chloromycetin
- Streptomycin
- Neomycin
- Penicillin
- Erythromycin
- Magnamycin
- Viomycin

*ACTIVE AT 160 mg/kg*
Graph 3
Dose of Various Antibiotics to give 80-100% Protection against Diplococcus pneumoniae Infection

Graph 4
Dose of Various Antibiotics to give 80-100% Protection against Listeria monocytogenes LM-2035 Infection
**Graph 5**

Dose of Various Antibiotics to give 80-100% Protection against *Erysipelothrix rhusiopathiae* ER-358 Infection

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Dose (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aureomycin</td>
<td>80-100</td>
</tr>
<tr>
<td>Achromycin</td>
<td>80-100</td>
</tr>
<tr>
<td>Terramycin</td>
<td>80-100</td>
</tr>
<tr>
<td>Chloromycetin</td>
<td>80-100</td>
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<tr>
<td>Streptomycin</td>
<td>80-100</td>
</tr>
<tr>
<td>Neomycin</td>
<td>80-100</td>
</tr>
<tr>
<td>Penicillin</td>
<td>80-100</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>80-100</td>
</tr>
<tr>
<td>Magnamycin</td>
<td>80-100</td>
</tr>
<tr>
<td>Viomycin</td>
<td>80-100</td>
</tr>
</tbody>
</table>

*Erysipelothrix rhusiopathiae* is even more difficult to control and this is reflected in the high dosage required to cure this infection which seems to have a predilection for bone marrow. This infection is also treated with four doses of antibiotic at the levels shown in Graph 5.

Graph 6 shows that anthrax is readily controlled by all the older antibiotics at 10 to 20 mg./kg. except chloromycetin. However, we dosed the animals on this test twice daily for four days.

Graph 7 in which the activity of the antibiotics against *P. multocida* is given shows it to be the most easily controlled of our experimental infections. Three doses of antibiotic are given, as with the streptococcus infection. Only Magnamycin (carbomycin), viomycin and chloromycetin required doses of more than 5 mg./kg. for 80-100 per cent survival.

The first seven infections are caused by the so-called Gram-positive bacteria and pasteurella, a Gram-negative which resembles them in its response to antibiotic therapy. *Klebsiella pneumoniae*, however, is Gram-negative and like most of the Gram-negative organisms is highly resistant to the penicillin-erythromycin-Magnamycin group of antibiotics. Our Type B infection, shown in Graph 8, is also rather resistant to the tetracyclines, especially Terramycin, and to viomycin but is readily controlled by streptomycin and neomycin. Six doses of antibiotics, at 1, 6, 18, 24, 48 and 72 hours are required to produce 80-100 per cent survival. The Type A infection, portrayed in Graph 9 is much more easily controlled by the tetracyclines and viomycin and even chloromycetin, which in earlier graphs, has shown up rather
Graph 6
Doses of Various Antibiotics to give 80-100% Protection against *Bacillus anthracis* Infection

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Dose mg/kg</th>
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<tbody>
<tr>
<td>Aureomycin</td>
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<tr>
<td>Achromycin</td>
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<tr>
<td>Terramycin</td>
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<tr>
<td>Chloromycetin</td>
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<tr>
<td>Streptomycin</td>
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<td>Neomycin</td>
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<td>Penicillin</td>
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<tr>
<td>Erythromycin</td>
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<td>Magnamycin</td>
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<tr>
<td>Viomycin</td>
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</tbody>
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Graph 7
Dose of Various Antibiotics to give 80-100% Protection against *Pasteurella multocida* P4.49 Infection

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Dose mg/kg</th>
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<tbody>
<tr>
<td>Aureomycin</td>
<td></td>
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<tr>
<td>Achromycin</td>
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<tr>
<td>Terramycin</td>
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<tr>
<td>Chloromycetin</td>
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<td>Streptomycin</td>
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<td>Neomycin</td>
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<td>Penicillin</td>
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<td>Erythromycin</td>
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<td>Magnamycin</td>
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<td>Viomycin</td>
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poorly, does quite well in this infection. Penicillin, erythromycin and Magnamycin were without effect. Only four doses of antibiotic are given in treating this infection.

In the experimental infections in which prolongation of survival time is the criterion of activity salmonella, in Graph 10, are most sensitive to neomycin followed by streptomycin and viomycin, chloromycetin and the tetracyclines. It should be noted that for our *Salmonella gallinarum* experiments, six-day-old chicks were used as test animals. They are treated once daily for four days. Tuberculosis, shown in Graph 11, is equally sensitive to streptomycin, neomycin and viomycin, with Achromycin and Terramycin somewhat less effective. The culture employed for these tests in mice was the well known human *M. tuberculosis* strain H$_3$Rv. These animals are treated once daily until fifty per cent of the controls are dead. This is usually 17 or 18 days.

Let us now reverse the process and look at each antibiotic in terms of all the infections.

Viomycin (Graph 12) has some activity against the Gram-negative infections but is virtually without effect on the Gram-positive organisms.

Magnamycin (Graph 13) has fair activity against streptococcus, diplococcus and pasteurella but has little activity against the staphylococci. It is not an impressive antibiotic.

Erythromycin (Graph 14) has good activity against the same three infections and is somewhat better against the staphylococci. However, it is not in any sense a broad spectrum antibiotic.

Penicillin (Graph 15) is a very effective antibiotic against the Gram-positive
Graph 9
Dose of Various Antibiotics to give 80-100% Protection against *Klebsiella pneumoniae* Type A Infection

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Dose, mg/kg</th>
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<tbody>
<tr>
<td>Aureomycin</td>
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<tr>
<td>Achromycin</td>
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<td>Terramycin</td>
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<tr>
<td>Chloromycetin</td>
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<td>Streptomycin</td>
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<td>Penicillin</td>
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<td>Erythromycin</td>
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<td>Magnamycin</td>
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<td>Viomycin</td>
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</tbody>
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Graph 10
Dose of Various Antibiotics to give 80-100% Protection against *Salmonella gallinarum* S.G.604 Infection

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Dose, mg/kg</th>
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<tbody>
<tr>
<td>Aureomycin</td>
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<tr>
<td>Achromycin</td>
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<tr>
<td>Terramycin</td>
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<tr>
<td>Chloromycetin</td>
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<td>Streptomycin</td>
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<td>Penicillin</td>
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<td>Erythromycin</td>
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<td>Magnamycin</td>
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<tr>
<td>Viomycin</td>
<td></td>
</tr>
</tbody>
</table>
Graph 11
Dose of Various Antibiotics to give 80-100% Protection against Mycobacterium tuberculosis H37Rv Infection

- Aureomycin
- Achromycin
- Terramycin
- Chloromycetin
- Streptomycin
- Neomycin
- Penicillin
- Erythromycin
- Magnamycin
- Viomycin

Graph 12
Dose mg/kg of Viomycin for 80-100% Protection

- Strept. pyogenes
- Staph. aureus
- Dip. pneumoniae
- L. monocytogenes
- E. rhusiopathiae
- B. anthracis
- Past. multocida
- K. pneumoniae Type B
- K. pneumoniae Type A
- Sal. gallinarum
- M. tuberculosis
Graph 13
Dose mg/kg of Magnamycin for 80-100% Protection

- Strept. pyogenes
- Staph. aureus
- Dip. pneumoniae
- L. monocytogenes
- E. rhusiopathiae
- B. anthracis
- Past. multocida
- K. pneumoniae Type B
- K. pneumoniae Type A
- Sal. gallinarum
- M. tuberculosis

Graph 14
Dose mg/kg of Erythromycin for 80-100% Protection

- Strept. pyogenes
- Staph. aureus
- Dip. pneumoniae
- L. monocytogenes
- E. rhusiopathiae
- B. anthracis
- Past. multocida
- K. pneumoniae Type B
- K. pneumoniae Type A
- Sal. gallinarum
- M. tuberculosis
Achromycin (Graph 20) is also active against all the infections and, in fact, it is a bit more active in the streptococcus, staphylococcus and listeria infections than is Terramycin.

Aureomycin (chlortetracycline) (Graph 21), the oldest of the broad-spectrum antibiotics is also the most effective of the tetracyclines against pasteurella and as good as either of the others against staphylococci, diplococci, erysipelofoxin, anthrax and klebsiella but it is not effective against tuberculosis.
Graph 16

Dose mg/kg of Neomycin for 80-100% Protection

- Strept. pyogenes
- Staph. aureus
- Dip. pneumoniae
- L. monocytogenes
- E. rhusiopathiae
- B. anthracis
- Past. multocida
- K. pneumoniae Type B
- K. pneumoniae Type A
- Sal. gallinarum
- M. tuberculosis

Dose, mg/kg

Graph 17

Dose mg/kg of Streptomycin for 80-100% Protection

- Strept. pyogenes
- Staph. aureus
- Dip. pneumoniae
- L. monocytogenes
- E. rhusiopathiae
- B. anthracis
- Past. multocida
- K. pneumoniae Type B
- K. pneumoniae Type A
- Sal. gallinarum
- M. tuberculosis
Graph 18

Dose mg/kg of Chloromycetin for 80-100% Protection

- Dip. pneumoniae
- Staph. aureus
- L. monocytogenes
- E. rhusiopathiae
- B. anthracis
- Paste. multocida
- K. pneumoniae Type B
- K. pneumoniae Type A
- Sal. gallinarum
- M. tuberculosis

Graph 19

Dose mg/kg of Terramycin for 80-100% Protection

- Dip. pneumoniae
- Staph. aureus
- L. monocytogenes
- E. rhusiopathiae
- B. anthracis
- Paste. multocida
- K. pneumoniae Type B
- K. pneumoniae Type A
- Sal. gallinarum
- M. tuberculosis
Graph 20
Dose mg/kg of Achromycin for 80-100% Protection

- Strept. pyogenes
- Staph. aureus
- Dip. pneumoniae
- L. monocytogenes
- E. rhusiopathiae
- B. anthracis
- Past. multocida
- K. pneumoniae Type B
- K. pneumoniae Type A
- Sal. gallinarum
- M. tuberculosis

Graph 21
Dose mg/kg of Aureomycin for 80-100% Protection

- Strept. pyogenes
- Staph. aureus
- Dip. pneumoniae
- L. monocytogenes
- E. rhusiopathiae
- B. anthracis
- Past. multocida
- K. pneumoniae Type B
- K. pneumoniae Type A
- Sal. gallinarum
- M. tuberculosis

Dose, mg/kg

94
# In Vitro Antibiotic Sensitivity of Pathogens of Veterinary Interest

<table>
<thead>
<tr>
<th></th>
<th>Mcg/ml Required for Growth Inhibition</th>
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<tbody>
<tr>
<td></td>
<td>Aureomycin</td>
</tr>
<tr>
<td><strong>Gram-positive organisms:</strong></td>
<td></td>
</tr>
<tr>
<td><em>B. anthracis</em></td>
<td>0.04</td>
</tr>
<tr>
<td><em>Strep. agalactiae</em></td>
<td>2.0</td>
</tr>
<tr>
<td><em>E. rhusiopathiae</em></td>
<td>0.5</td>
</tr>
<tr>
<td><em>L. monocytogenes</em></td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Gram-negative organisms:</strong></td>
<td></td>
</tr>
<tr>
<td><em>K. pneumoniae</em>, Type A</td>
<td>0.5</td>
</tr>
<tr>
<td><em>K. pneumoniae</em>, Type B</td>
<td>5.0</td>
</tr>
<tr>
<td><em>Past. multocida</em></td>
<td>0.25</td>
</tr>
<tr>
<td><em>Sal. gallinarum</em></td>
<td>1.25</td>
</tr>
<tr>
<td><em>Sal. choleraesuis</em></td>
<td>16.0</td>
</tr>
<tr>
<td><em>Shigella paradysenteriae</em></td>
<td>8.0</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td>8.0</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>62.5</td>
</tr>
<tr>
<td><em>Proteus vulgaris</em></td>
<td>4.0</td>
</tr>
<tr>
<td><em>Vibrio fetus</em></td>
<td>0.08</td>
</tr>
<tr>
<td><em>Moraxella bovis</em></td>
<td>0.12</td>
</tr>
<tr>
<td>PPLO (6 avian strains)</td>
<td>0.8-3.2</td>
</tr>
</tbody>
</table>
A number of pathogenic bacteria of veterinary interest have been tested for in vitro sensitivity to the various antibiotics. These include not only the strains used in our in vivo tests but also a number of others for which we have not yet developed a satisfactory test or which we have not yet had an opportunity to test.

These organisms were all tested by a tube dilution method previously described (4). The results are shown in Table 1. Viomycin is virtually inactive in vitro. Erythromycin and Magnamycin were active against the Gram-positive but relatively inactive against all of the Gram-negative bacteria except P. multocida. Streptomycin and neomycin were unimpressive in these tests but we were using a poor medium to demonstrate activity of these antibiotics. Penicillin was very active against the Gram-positive organisms except, L. monocytogenes, and against P. multocida and V. fetus but had little effect on the other Gram-negative bacteria. Chloromycetin was moderately active against all the organisms except Pseudomonas aeruginosa. Terramycin showed considerably better over-all activity than did chloromycetin while Achromycin was slightly better than Terramycin and Aureomycin was as good as Achromycin with the exception of Pseudomonas aeruginosa and Sal. choleraesuis.

Attention might be called to the last item in Table 1. The pleuropneumonia group of organisms are in a taxonomic class of their own which is considered to be intermediate between the true bacteria and the viruses. These organisms are the causative agent of bovine pleuropneumonia and agalactia in sheep and goats, a disease which is common in Europe and North Africa. Pleuropneumonia-like organisms have been implicated in a chronic respiratory disease of fowls which has recently become fairly widespread in the United States. It is well established that penicillin and the sulfonamides are ineffective against these organisms. Our in vitro tests with 10 strains isolated from poultry with chronic respiratory disease showed that they

<p>| TABLE 2 |</p>
<table>
<thead>
<tr>
<th>Acute Toxicity of Antibiotics</th>
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<tr>
<td>Single dose (mg./kg.) lethal for 50 per cent of mice tested. Data compiled from various sources.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Route</th>
<th>Intravenous</th>
<th>Intraperitoneal</th>
<th>Subcutaneous</th>
<th>Oral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aureomycin</td>
<td>134</td>
<td>&gt;200</td>
<td>3000–4000</td>
<td>&gt;1500</td>
</tr>
<tr>
<td>Achromycin</td>
<td>162</td>
<td>190</td>
<td>600–650</td>
<td>2130</td>
</tr>
<tr>
<td>Terramycin</td>
<td>178</td>
<td>200</td>
<td>600–650</td>
<td>7200</td>
</tr>
<tr>
<td>Chloromycetin</td>
<td>100–200</td>
<td>1320</td>
<td>Insoluble</td>
<td>2640</td>
</tr>
<tr>
<td>Streptomycin</td>
<td>150–225</td>
<td>600–750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viomycin</td>
<td>240</td>
<td>1380</td>
<td></td>
<td>7500</td>
</tr>
<tr>
<td>Neomycin</td>
<td>550</td>
<td>400</td>
<td>450</td>
<td>&gt;6450</td>
</tr>
<tr>
<td>Magnamycin</td>
<td>425</td>
<td>490</td>
<td>2850</td>
<td>&gt;3500</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>1000–2000</td>
<td></td>
<td>1850</td>
<td>2925</td>
</tr>
<tr>
<td>Penicillin</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
were all very sensitive to the three tetracycline antibiotics and Magnamycin and highly resistant to penicillin.

Table 2 gives the dose in mg./kg. required to kill fifty per cent of mice tested. Penicillin is the least toxic of the antibiotics. Magnamycin and erythromycin show a low order of intravenous toxicity. The other antibiotics do not differ greatly in intravenous toxicity and all have a wide margin of safety. The very high oral values for neomycin and viomycin reflect their very poor absorption. All of these antibiotics have wide safety margins for oral administration.

SUMMARY

We have evaluated Aureomycin, Achromycin, Terramycin, chloromycetin, penicillin, streptomycin, neomycin, viomycin, erythromycin and Magnamycin against experimental infections with Streptococcus hemolyticus, Staphylococcus aureus, Diplococcus pneumoniae, Listeria monocytogenes, Erysipelothrix rhusiopathiae, Bacillus anthracis, Pasteurella multocida, Klebsiella pneumoniae, Types A and B, Salmonella gallinarum and Mycobacterium tuberculosis.

In general the tetracycline antibiotics were effective in a lower dose and against a wider range of organisms than were the other antibiotics. Chloromycetin was much less effective than any of the tetracycline antibiotics. Streptomycin had a wide spectrum of activity at a low dosage. Penicillin was effective at very low dosage against the Gram-positive cocci, B. anthracis and E. rhusiopathiae. Erythromycin and Magnamycin were very effective against the streptococcus infection, Diplococcus pneumoniae and the pasteurella infection and erythromycin was fairly effective against the staphylococcus but they were unimpressive against the other infections. Neomycin was highly active against the Gram-negative bacteria, and B. anthracis, good against M. tuberculosis and fair against streptococci and staphylococci. Viomycin showed fair activity against the Gram-negative bacteria and M. tuberculosis but little or none against the other organisms. Vibrio fetus and Moraxella bovis and six avian strains of PPLO organism were sensitive in vitro to the tetracyclines. Vibrio fetus was also sensitive to penicillin, streptomycin and chloromycetin.

Toxicity of all the antibiotics was low compared to therapeutic effectiveness in the infections where they were most useful.

REFERENCES


REPORT OF COMMITTEE ON BIOLOGICALS AND PHARMACEUTICALS

MARK WELSH, Pearl River, N. Y., Chairman; W. A. CLARK, Denver, Colorado; SIVERT ERiKSEN, Madison, Wisconsin; CARL NORDEN, Jr., Lincoln, Nebraska; M. PANISSET, Montreal, Canada; A. H. QUIN, Kansas City, Kansas; S. F. SCHEIDY, Drexel Hill, Pennsylvania; RALPH L. WEST, St. Paul, Minnesota

During the year of 1954, no spectacular biological or pharmaceutical of widespread application has come on the market. Your Committee on Biologicals and Pharmaceuticals, however, have carefully reviewed the data in these fields and feel that very solid progress has been made. There have, however, been several products that appeared on the market which are combinations of one or more agents previously proved effective and these combinations have simplified immunization procedures or, in other instances, permitted a broader therapeutic action.

CANINE DISTEMPER-HEPATITIS VACCINE

This problem has been approached in two ways. Various companies have introduced a Modified Live Virus Distemper Vaccine used in conjunction with Killed Hepatitis Vaccine for the protection of dogs. Another approach to the same problem has been the use of killed tissue vaccine for distemper and hepatitis combined in a single injection.

HOG CHOLERA

Data was presented at a Federal hearing last July on Hog Cholera immunizing agents which your Committee feels should be given widespread recognition by inclusion in this report.

1. 62 per cent of farms in United States produce hogs. 70 per cent of farms in the North Central States produce hogs. 85 per cent of Iowa farms produce hogs.
2. Approximately 10-12 per cent of the national farm income is derived from hogs.
3. Cash receipts from hogs in United States in 1951 was $3,901,767,000; in 1952, $3,517,110,000.
4. Total value of hogs raised, including sold and used on farms: 1951—$4,266,453,000; 1952—$3,570,110,000.
5. Total hog slaughter 1953—77,690,100, sold; 9,022,000, used on farm. Total—86,712,100.
6. Hog-corn ratio: Number of bushels of corn required to buy 100 lbs. of live hogs at local markets, based on average prices received by farmers for hogs and corn. Currently this ratio is favorable.
7. Pork consumption: a) Annual per capita—67 to 70 lbs. b) Constitutes about 50 per cent of meat consumed. c) An important and ready food for the military services.
8. Provides greatest outlet for use of grains raised on farms.

There is much additional data that was interesting but too voluminous to be re-
corded here. It is, however, significant that in the last five years a higher percentage of total hogs produced in the United States were vaccinated than in any previous period, and in 1953 55.3 per cent of the hogs in the United States were vaccinated. Swine protected with vaccines has increased about four times since 1950 and a little over 19 million were so protected in 1953.

Other reports continued to indicate that vaccines are being increasingly used in the protection of swine against Hog Cholera and that virulent virus is being restricted or prohibited in some areas. Previous committees have recommended that virulent hog cholera virus should be stricken from the list of products that can be sold intrastate for Hog Cholera vaccination in this country. We believe that vaccination of swine with modified live hog cholera virus vaccines, with inactive hog cholera vaccines, and anti-hog cholera serum had been demonstrated on a sufficiently large number of animals over an adequate period of time to prove their value. The dangers attendant the use of virulent virus is too well known and recognized to need repetition here. We recommend, therefore, that Federal and State officials again review the promiscuous distribution of virulent virus now common to the majority of our states, and the results obtained with the newer type vaccines and make such changes in their laws and regulations as will adequately protect the swine industry.

BRUCELLOSIS

The Milk Ring Test for identifying brucellosis in dairy herds is being more widely used and its value more accurately determined. When used as a presumptive test of infection in a herd and followed up by blood tests on the individual animals, time and labor are saved and the work promoted faster with the funds available. Many feel that the Ring Test may serve the same useful purpose in the control and eradication of brucellosis that the intradermal test did in similar eradication programs on Bovine Tuberculosis. It cannot safely be considered in any sense as a substitute for systematic blood testing but rather as an adjunct thereto permitting more rapid reduction of the incidence of this disease in cattle. We wish to remind you that last year your committee on brucellosis recommended that only desiccated brucella abortus vaccine, strain 19 be used in the vaccination of cattle against brucellosis. Our committee concurs in this recommendation which further states that the use of the liquid vaccine be discontinued after January 1, 1956. The reasons for this change are obvious and need no further discussion here.

NEWCASTLE DISEASE VACCINES

Three new forms of Newcastle Disease vaccines were introduced in the past year. All of these were designed to mass vaccinate large numbers of birds with a minimum of effort and no unnecessary handling of the birds. In one of these new type vaccines, a modified live virus is simply added to the drinking water; in another the virus is adsorbed on dust of a standard particle size; and the third is administered as a mist or spray. This dust, or mist, is sprayed over the birds and inoculation occurs through the mouth, eyes, and nose. Obviously, in any mass vaccination of these types, individual birds which are not good candidates for immunization must be included in the group and certain losses must be expected.
Considering the savings in time and labor, apparently these losses may be accepted and the owner still comes out ahead rather than bear the higher costs of older methods. These new methods of mass vaccination of poultry may be equally applicable to other types of animals and it is reported that experimental trials toward this end are in progress. Whether these new approaches to the protection of our domestic stock are desirable or not from an over-all point of view will require more time and study.

In the meantime, they should be objectively evaluated and conclusions drawn on the basis of proved fact rather than opinion or prejudice.

A new product has also reached the market by which birds can be immunized against Newcastle Disease and Bronchitis simultaneously. Each of these vaccines is prepared separately but are combined in the drinking water for immunization purposes. We can anticipate that more of this type of combined vaccine will appear on the market in the near future.

Some progress has been made within the past year in solving the problem of having unlicensed poultry vaccines produced and distributed within a state. Unfortunately, the Federal Government has no control over such distribution within a state and most states have no laws or regulations by which this practice can be controlled, so the situation serves as an open invitation for continuance of the distribution of unlicensed products.

We have no reason to believe that the production and distribution of unlicensed vaccines will necessarily be confined to the poultry field. The dangers are too obvious to need further discussion here, but your Committee would like to forcefully call this problem to the attention of State and Federal regulatory officials. We believe that the problem is serious and that action should be taken before damage is done. We feel that it is better that official action be taken while the problem can be calmly and deliberately studied rather than that these officials be forced into hasty action because of serious losses within a state or area.

ERYSIPELAS

Within the past year, what was reported to be an efficient immunizing agent against Swine Erysipelas has appeared on the market. These Swine Erysipelas bacterins are made from immunogenic strains of organisms isolated in the highly infected areas of the Scandinavian countries and Germany, and similar bacterins have been used there for many years. These products have been sufficiently evaluated in the immunization of swine and turkeys that there seems little doubt of their safety and efficiency for the protection of these species against *Erysipelothrix rhusiopathiae*. The duration of immunity, however, has not been definitely established.

ANTIBIOTICS

During the week of October 25th, there was held in Washington under the auspices of the United States Department of Health, Education, and Welfare, a symposium on Antibiotics. Many of the papers presented had a direct or indirect bearing on Veterinary medicine, and the application of these products to animal
disease or its prevention. These extensive papers will be available to the public in the near future.

There is being presented at this meeting a comparison of several of the currently available antibiotics against specific diseases in laboratory animals. Your Committee feels that it could not summarize all of this vast data that has so recently been made available, and would suggest that those interested make direct application for reprints of these papers.

It should be observed in passing, that many combinations of antibiotics have appeared on the market in the last year. Also, means have been found to extend the period of activity of many of the antibiotics which presumably lengthens the period of usefulness. These agents are being used in a great number of mill feeds to control low grade infections and to stimulate the growth of animals. Virtually all species of domestic animals seem to be benefited by the inclusion of these antibiotic products in their diet. This is particularly true of young animals. There are even those who believe that thoroughbreds having antibiotics in their diet are able to run faster, but there are others that wonder why they don't. In any case, it looks as if antibiotics in the feed of domestic animals is broadly beneficial and the practice is here to stay.

Rumen Micro-organisms

For the past few years, there has been an increasing interest in the study of the microbiology of the rumen. The work at Universities such as Purdue, Illinois, Wisconsin, and other institutions has shown that roughages of presumed poor feeding value such as corn cobs, poor quality hay, and similar materials, can be profitably utilized in the diet of ruminants if they have the right type of microflora, and the diet is properly balanced. Several new products have appeared on the market, many of which contain dried rumen organisms and nutrient materials which presumably stimulate the growth of the rumen micro-organisms.

It is the opinion of your Committee that much research work remains to be done before we have a full understanding of what goes on in the rumen and what its exact needs may be in microbial nutrients to economically transform roughages of poor quality into profitable meat or milk. We do feel, however, that progress is being made and that such studies should be encouraged. It is our understanding that only about 15 per cent of the meat that comes on our markets is grain-fed. It seems very reasonable that, if the other 85 per cent could be improved in quality and amount through more efficient rumen action, it would constitute a notable advance in our economy.

Leptospirosis

Leptospirosis has been widely reported in dogs for many years but less frequently in cattle. It now seems that infections due to *Leptospira pomona* are quite widespread among cattle and other domestic livestock. As diagnostic methods have improved, it appears to be a more frequent cause of death than was previously supposed. Within the past year, a vaccine has been produced to immunize animals against *Leptospira pomona* but because of the nature of the disease it is difficult to accurately evaluate. It would seem desirable, however, that, when the infection
has been proved in a herd, this new immunizing agent be employed, and it is hoped that the accumulation of data on large numbers of such vaccinated animals will give the answers that are needed for a more exact evaluation than is now possible.

**BLUETONGUE**

Within the past year, Bluetongue vaccines have appeared on the market for the immunization of sheep against this infection. There are several strains of Bluetongue virus known and few of these will cross-immunize. So far as is known, the vaccine used here immunizes against the majority if not all of the strains that cause Bluetongue in this country. These vaccines have been in use for only a few months and the only reports are favorable but not necessarily conclusive in regard to their effectiveness. At present, however, these vaccines are our best hope of controlling this disease in sheep.

**BOVINE KETOsis**

Cortisone and similar hormonal products have, within the last year, been offered on the market as an effective means of treating Bovine Ketosis. The research data on this problem leaves little doubt that Ketosis is caused by certain hormone deficiencies and that prompt correction can be expected through hormonal therapy. It is the feeling of your Committee that the intensive study of hormones now going on will, in the near future, give us new tools of therapy to work with and a better understanding of various animal diseases.

In many respects the problems involving the glands of internal secretion are similar to the vitamin problems of 25 years ago. There is an inter-relationship of hormones, one with another, and these in turn are influenced by nutritional and environmental factors, among others. The chicken is again proving a useful laboratory test animal as feathering patterns, growth and weight gains, feed utilization efficiency, age of maturity, rate of egg production, and other factors can rapidly be determined, and the whole life cycle completed within a year. We would recommend that those interested in this important field of endocrinology keep scrutinizing the work of the poultry research workshops as well as those working on a mammalian species.

**ORGANIC PHOSPHORUS COMPOUNDS**

Several reports have appeared in the technical and semi-technical literature concerning the effectiveness of organic phosphorous compounds in the treatment of external and internal parasites. It is our understanding that, as a whole, these compounds are quite toxic and may be accumulative in the tissues. Certain of them, however, when injected subcutaneously, are reported as killing ox warbles, screwworms, and mange mites. Some of the data indicates that following one injection animals are protected against screwworms for approximately six weeks. These products have not yet appeared on the market but your Committee felt that they should be reported to you as the data has appeared in the literature, and the use of these phosphorous compounds constitutes a new and interesting approach to an old and costly problem.
TRENDS IN RESEARCH

Anyone who has observed the research field for a period of years comes to a realization that there are trends and fads in this field as there are in all others. At the present time, it would appear that the fields of work in which greatest interest is being shown are in the hormone-enzyme therapy, in the development of new and better sedatives, in the combining of currently available antibiotics, and in the uniting of these with other agents to gain the benefits of two or three effective agents simultaneously. Particularly, in the poultry field, there is a great interest in developing methods for cheap and effective mass-vaccination of large numbers of birds. This could and probably will be extended to the immunization of other species of domestic animals kept in large numbers. These new methods will bear the close scrutiny of all regulatory officials as well as stockmen and poultrymen. As previously indicated, there seems to be a keen interest in the development of new and better insecticides and parasiticides and interesting new screening programs are in progress, of which the phosphates are merely one example.

No one in the past year has made any major contributions to the solution of such old problems as anaplasmosis, trichomoniasis, vibrio fetus, pink eye, infectious rhinitis, foot rot, and several others that could be mentioned. Chronic respiratory disease is a relatively new disease of poultry that makes it increasingly difficult for poultrymen to make a profit. Leucosis is also a chronic poultry disease that has been with us so long that perhaps we are getting too accustomed to it. It has however been under continuous study for 20 years or more and, although our understanding of it has advanced, we are yet to develop practical means of control.

We would like to encourage Federal and State agencies to continue their investigation of these chronic but costly diseases. We realize that it is often difficult to get State and Federal appropriations for the study of diseases of this kind that are neither acute nor spectacular, but certainly are costly. Your Committee feels that an adequate system in this country for the collection of mortality and morbidity statistics would point up these problems and show them in their true economic perspective. We feel, also, that these diseases are exacting a tax from our livestock and poultry breeders that is large in the aggregate, and must continue to be paid annually until means of treatment or prevention is found. Withholding funds for the study of these problems is doubtful economy.

Finally, your Committee would like to call attention to the administrative changes that have been made in the Federal Government, and we feel that the agencies having to do with livestock work should be congratulated on their new approach to their duties and responsibilities. While it is recognized that much of the personnel is competent, it must be admitted that the agencies, as a whole, are seriously under-staffed and are at present not adequately equipped to fully carry out the details of their responsibilities. Your Committee feels that the Agricultural Research Service needs laboratory facilities for testing products that are now on the market to be certain that standards are maintained and that safety is insured. It is believed, also, that it would be to the best interests of the livestock industry that the Agricultural Research Service in cooperation with industry adopt mini-
mum standards and uniform testing procedures for products offered for the treat-
ment of animals.

Finally, we would again call attention to the vital need of controlling products that are produced and distributed within a state that are used for the treatment or immunization of domestic stock. Products that are not good enough for the neighbors are not good enough for the homefolks. A few states have recognized the problem and the danger and are doing something about it. We are assured that the Agricultural Research Service, the United States Livestock Sanitary Association, and other National agencies interested in livestock, are well aware of the problem and its dangers and will freely give their help. Your Committee strongly recommends that this association as a whole, and that its members as individuals, take an active interest in establishing state organizations that can properly pro-
tect our vital livestock interests in peace as well as in time of war.
A COMPARISON OF ANTIGEN PRODUCTION METHODS AND COMPLEMENT-FIXATION PROCEDURES FOR DIAGNOSING BOVINE ANAPLASMOSIS

AND JAMES MITCHELL†, B.S.

The complement-fixation test was first applied to the diagnosis of bovine anaplasmosis in 1934. Mohler and Rees (1) produced a tick antigen which gave encouraging results when used in the test. However, they were unable to produce this antigen in sufficient quantity for experimental testing. The work was therefore discontinued. In 1944 the United States Bureau of Animal Industry resumed work on this problem and developed a crude blood antigen. A technique, similar to that developed by Kent, Bukantz, and Rein (2) of the Army Medical School, Washington, D. C. was used to produce this antigen. It could be produced in quantity, but had the following disadvantages (A) it contained too much color which interfered with reading the test, (B) the antigenic content was not uniform, resulting in some of the antigens giving a negative reaction and (C) many of the antigens were anticomplementary which rendered them useless when used in the test. The following year a carbon dioxide precipitate antigen was prepared by the Bureau using a technique developed by Heidelberger and Mayer (3), which eliminated most of the color and resulted in a more uniform antigen. However, many of the antigens were anticomplementary. The test has not been recommended for practical use until the present time because of continued difficulty in attempts to separate the antigen from the anticomplementary fractions of the antigens.

In 1950 Price, Poelma, and Faber (4) of the Maryland Livestock Sanitary Service produced an antigen in which the red cells were lysed with distilled water. This antigen gave a higher titer and was less anticomplementary than the CO₂ antigen. Miller (5) (1952) modified the above technique utilizing the Sharples centrifuge in an effort to put antigen production on a more practical basis.

During the past five years several laboratories have been conducting the test and some of them are producing their own antigen. The testing and antigen production methods used by these laboratories are not uniform. Many variations of the testing technique and production methods have been made. As time went by these variations became more pronounced and as a result, a great variation existed in the results from these laboratories. More uniformity or standardization is needed before any large scale testing program can be undertaken. This will require additional research in order to obtain the necessary information on which to base the standardization. It is the purpose of this paper to report on a comparison of two

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† L. J. Poelma, K. E. Price, James Mitchell, Maryland Livestock Sanitary Service, College Park, Maryland.
testing techniques and three methods of producing antigen when all the reagents including the antigens were derived from a common source.

ANAPLASMOSIS PASSAGE AND ANTIGEN DONOR ANIMALS

Splenectomized calves, 400 to 600 pounds in weight were used for the initial passage (one to four) from the carriers to increase the disease virulence and observe the strain characteristics. Large cows, five to ten years of age, with spleens intact, weighing 1200 to 1500 pounds were subinoculated from the infected calves for antigen donor material.

It is believed the inoculation method and preliminary passages are the most important steps in the production of a good antigen. Rapid serial passages in which large doses (.5 cc. of packed cells per pound body weight) injected intravenously gave satisfactory results. The blood used for inoculation was collected in closed flasks containing sufficient sodium citrate to make a final dilution of .5 per cent (25 cc. of a 20 per cent solution of sodium citrate per 1000 cc. of blood) and processed immediately.

The blood was placed in 250 cc. pyrex centrifuge bottles and centrifuged at 2000 r.p.m. (1100 g.) for 20 minutes, after which the plasma was siphoned off and discarded. The red cells were given one wash by resuspending in physiological saline solution and centrifuged again for 20 minutes at 2000 r.p.m. The supernatant was drawn off and discarded, the packed cell volume was measured and the cells resuspended in an equal volume of physiological saline. This parasitized red cell saline suspension was injected intravenously into the next passage animal. The inoculations were made as soon as the processing was completed. All forms of refrigeration were avoided since over-night refrigeration of acute blood at 4°C. has been shown to lengthen the incubation period as much as 10 to 15 days. Two strains of anaplasmosis were used for these experiments. A Louisiana strain identified as O series received five passages in eight animals. A Virginia strain identified as P series received seven passages in 16 animals (only two cows from the O series and four cows from the P series were used for comparative studies).

HARVEST

The course of the disease was closely followed after inoculation by daily checking the thermal reaction, red cell volume, number of parasitized red cells and clinical reactions in order to determine the proper time to harvest the blood. Originally it was thought that the most desirable antigens were produced by obtaining the maximum number of parasitized red cells. The amount of parasitized cell approximately doubles every 24 hours and may go as high as 80 per cent. In order to obtain this result the red cell volume was permitted to reach a minimum of 10 per cent before the blood was collected. As a result of previous work it is now thought that this method of harvesting the blood results in a higher percentage of anti-complementary antigens due to the great amount of red cell destruction which has taken place and/or to the high antibody content of the serum. Therefore, it was decided to collect the blood from the infected animals in this experiment when the red cell volume was approximately 20 per cent and when 50 per cent of the cells were parasitized. By using this method the harvest time was advanced from
one to three days, the total number of parasites obtained was approximately the same as that obtained when the former method was employed and most of the resulting antigens were less anticomplementary. Immediately following collection the blood was mixed to insure uniformity. At this point the total amount of blood was recorded and divided into two equal lots, one of which was delivered to the Maryland laboratory and the remaining portion made into antigen at the Animal Disease Station.

**ANTIGEN PRODUCTION METHODS**

*Carbon Dioxide Precipitate Antigen (CO₂ Antigen)* (7)

The processing of the citrated blood was started immediately after the blood was harvested by centrifuging at 2000 r.p.m. (1100 g.) and removing the plasma. The red cells were given six washes by resuspending in physiological saline, and centrifuged at 2000 r.p.m. One volume of washed red cells was added to approximately 30 volumes of carbon dioxide saturated, ice cold, distilled water, which was agitated, and placed in the refrigerator until a pink precipitate had settled to the bottom of the container. About four hours later the supernatant fluid was drawn off and discarded. The precipitate was centrifuged and washed in ice cold, distilled water until the supernatant fluid contained no color. Most of the hemoglobin color which interferes with reading the complement-fixation test was in this way removed. This usually requires three or more washings. The carbon dioxide precipitate is soluble in salt water and usually shows an acid reaction of about pH 5. The amount of washed, packed precipitate was measured, the acidity neutralized with 1.0 per cent sodium bicarbonate solution and physiological saline added in sufficient quantity to make a standard concentration of antigen equal to three times the volume of the packed precipitate. The finished antigen was then frozen and stored at -70°C. until tested. The estimated time required to produce the carbon dioxide antigen is three-man-hours per liter of blood.

*Servall Distilled Water Extract (Servall Antigen)* (4)

The plasma was removed and the cells washed four times in physiological saline by centrifuging at 2500 r.p.m. (1700 g.) for 20 minutes. The packed cells were lysed by adding distilled water in the proportion of 15 volumes of distilled water to one volume of packed cells and allowed to stand for 90 minutes at 4° to 6°C. This material was centrifuged in a Servall angle centrifuge for 30 minutes at not less than 5000 r.p.m. (3000 g.). The sediment was pooled and washed repeatedly in distilled water until the supernatant was hemoglobin-free. The sediment was triturated with a glass stirring rod and resuspended in distilled water. Following another centrifugation, two different though poorly defined layers were observed. The bottom one appeared as a heavy, well-packed layer, grayish in color and the upper layer consisted of a light, fluffy, brownish mass. The upper layer was partially removed with an aspirating pipette and the sediment again ground, resuspended, and centrifuged in order to remove more of the fluffy material. The gradual removal of the upper layer was necessary to avoid too great a loss of the packed lower layer. This process was repeated until a smooth homogeneous button-like sediment remained. The sediment was washed free from the
centrifuge tubes with a small quantity of distilled water, pooled, and distributed into 20 ml. vaccine bottles in 7 ml. quantities. The antigen was frozen and stored at \(-70^\circ\text{C.}\) until tested. The estimated time required to produce the Servall antigen is 4.3-man-hours per liter of blood.

The Sharples Distilled Water Extract (Sharples Antigen) (6)

The blood was centrifuged for 20 minutes at 2000 r.p.m. (1100 g.) and the plasma removed. The red cells were washed four times in 0.85 per cent saline solution for 20 minutes at 2500 r.p.m. (1700 g.). The packed cells were lysed by adding 16 volumes of distilled water to one volume of packed cells. This mixture was allowed to stand for 90 minutes at 4° to 6°C., to allow enough time for complete lysis. The solution of hemolized corpuscles was then passed through a Sharples centrifuge equipped with a clarifying bowl operating at 40 to 50 thousand r.p.m. (40,000 g.) The rate of flow was approximately 2.0 liters per hour. During operation of the centrifuge, the bowl was cooled by means of a refrigeration unit. After 12 liters had passed through the centrifuge, it was stopped, the bowl removed, and solids were collected from the inside wall. This material was weighed and a small portion diluted for antigen titration. After the results were obtained, the total solids were thoroughly mixed with sufficient distilled water so that each ml. of antigen was enough for approximately 50 tests. The antigen was then dispensed in vials in two ml. amounts and placed in a deep freeze, where it was maintained at \(-50^\circ\text{C.}\) until it is removed for test. The estimated time required to produce the Sharples antigen was 2.4 man hours per liter of blood.

Results of Tests on Antigens Produced by Different Methods

The Animal Disease and Parasite Research Branch of the United States Department of Agriculture and the Maryland Livestock Sanitary Service conducted an experiment in which their antigen production methods and testing techniques were compared. In order to compare the antigen production methods, the two agencies entered into an agreement, whereby the Animal Disease Station produced the acute anaplasmosis blood. The blood obtained from six acute cases of anaplasmosis (cows with spleens intact) was processed by the two laboratories. One half of the blood from four of these animals was made into Servall and Sharples antigens at the Maryland laboratory. The remaining half of the blood from the four animals was made into CO₂ antigen at the Animal Disease Station. One half of the blood from the two remaining animals was made into Sharples antigen by the Maryland laboratory and the remainder of the blood from the two cows was made into CO₂ antigen at the Animal Disease Station.

All the antigens were tested by both the Maryland and the United States laboratories. Each antigen was tested at both laboratories with United States and Maryland positive and negative sera. All the additional reagents used by both laboratories originated from a common source except the saline. Table I shows the results obtained when six antigens were tested by both the United States and Maryland laboratories. The United States test figures are based on United States testing and expressed in United States test units per cc. of blood. They were obtained by multiplying the antigen volume in cc. by the end point 4+ titer times one (the number of United States test units per cc. of antigen) divided by the cc. of blood.


TABLE I

United States Test Units per cc. of Blood

<table>
<thead>
<tr>
<th>Antigen Number</th>
<th>R.C.V.</th>
<th>Parasite Count</th>
<th>Co₂ Method</th>
<th>Servall Method</th>
<th>Sharples Method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>cc.</td>
<td>cc.</td>
<td>U.S. Test</td>
<td>Md. Test</td>
<td>Blood</td>
</tr>
<tr>
<td>O5-3085</td>
<td>20.5</td>
<td>42.0</td>
<td>12250</td>
<td>2415</td>
<td>3062</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.501</td>
<td>2.365</td>
<td>.784</td>
</tr>
<tr>
<td>P2-3321</td>
<td>18.0</td>
<td>56.0</td>
<td>11000</td>
<td>2160</td>
<td>7332</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.785</td>
<td>2.945</td>
<td>1.571</td>
</tr>
<tr>
<td>P3-3360</td>
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<td>55.0</td>
<td>11250</td>
<td>2370</td>
<td>5625</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>1.896</td>
<td>3.160</td>
<td>7.680</td>
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<tr>
<td>P6-3422</td>
<td>19.0</td>
<td>53.0</td>
<td>13850</td>
<td>2295</td>
<td>850</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>.331</td>
<td>2.485</td>
<td>1.810</td>
</tr>
<tr>
<td>Average</td>
<td>.900</td>
<td>2.738</td>
<td>1.367</td>
<td>5.276</td>
<td>1.233</td>
</tr>
</tbody>
</table>

The Maryland test figures are based on Maryland testing and expressed in United States test units per cc. of blood. They were obtained by multiplying the volume of antigen in cc.'s by the end point 4+ titer times 3.33 (the number of Maryland test units per cc. of antigen) divided by the cc. of blood processed. The Maryland units were then converted into equivalent United States test units by dividing by 3.33 (conversion factor). This conversion factor is the result of difference in the volume of antigen. One cc. of antigen is used in the United States test whereas the Maryland method requires only .3 cc. As an example the information on Table I was obtained as follows: line 1 of Table I shows that 12,250 cc. of blood from cow 3085 was made into 2,415 cc. of CO₂ antigen. The application of the above formula to this data shows how the number of test units per cc. of blood were obtained.

antigen volume 2,415 cc. × 3 (1:3 dilution = antigen titer)

X 1 (1 cc. = antigen test unit volume per cc.)

blood volume = 12,250 cc.

= 0.591 United States antigen test units per cc. of blood based on the United States test unit.

The Maryland laboratory reported an antigen titer of 1:12 for the same antigen, therefore again the application of the above formula shows:

antigen volume = 2,415 cc. × 12 (1:12 dilution = antigen titer)

X 3.33 (3.33 test units per cc. of antigen)

blood volume = 12,250 cc.

= 7.877 Maryland antigen test units per cc. of blood
The conversion of the Maryland test units in Table I was made by dividing 7.877 by 3.33 equals 2.365 United States test units per cc. of blood based on the Maryland test.

After this adjustment for test volume, the Maryland test obtained 2.365 test units per cc. of blood, and the United States test obtained 0.591 test units per cc. of blood from the same antigen. Therefore the Maryland test obtains four times as many units as the United States test obtains—(0.591 \times 4 = 2.364) or the United States test unit is 4 times larger than the Maryland unit adjusted to the same volume. All the other antigens prepared were compared on a similar basis in Table I and all show a similar variation in the antigen test unit between the two tests.

COMPLEMENT-FIXATION TECHNIQUES

In order to compare the complement-fixation testing techniques employed by the Maryland laboratory and that used by the United States laboratory in Washington, D. C., it was decided to conduct an experiment in which 100 serum samples from animals of known anaplasmosis status were tested by both laboratories. These samples consisted of 50 known positive samples and 49 negative samples (one sample was removed due to a questionable status). The samples were collected from animals in the anaplasmosis experimental herd located at the Animal Disease Station, Beltsville, Maryland. A careful record of all inoculations have been kept on this herd. Complement-fixation tests are conducted monthly and subinoculations are made into splenectomized calves at irregular intervals, in order to determine the exact status of each animal. One cc. of a 5 per cent phenol solution was added to each 9 cc. of serum as a preservative. Each sample was divided into two

| TABLE II | A Comparison of the Maryland and U. S. Complement-Fixation Test for Bovine Anaplasmosis |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Sera storage    | -50°C.          | 4°C.            |
| Sera inactivation | 56°C.          | 58°C.          |
| Complement storage   | -50°C.          | -50°C.        |
| Units of complement used in the test | 3—based on 50% hemolysis | 1\(\frac{1}{2}\) based on 100% hemolysis |
| Units of Amboceptor  | 3—based on 50% hemolysis | 2.5 based on 100% hemolysis |
| Red cell standardization | Spectrophotometrically | Volumetrically |
| Aliquots          | 3 cc.           | 1.0 cc.        |
| Total volume      | 1.5 cc.         | 5 cc.          |
| Incubation        | Water           | Air            |
| Temperature       | 37°C.           | 37°C.          |
| Incubation time   |                 |                 |
| (a) Fixation      | 60 min.         | 60 min.        |
| (b) Hemolytic     | 30 min.         | 45 min.        |
parts, both laboratories received duplicate samples marked with the same code number. The status of the animals were unknown to the serologists in both the Maryland and the Washington, D. C. laboratories. All the reagents used in testing these sera originated from a common source except the saline. Table II shows a comparison of the two testing techniques.

In order to determine the per cent accuracy of each laboratory report it was necessary to assign numerical values to each type of reaction. Table III shows the values assigned to these reactions. Table IV shows the complement-fixation test results obtained by both laboratories on 50 known positive anaplasmosis serum samples. The Maryland laboratory reported 28 four-plus, 8 three-plus, 6 two-plus 4 negative and 4 anticomplementary samples. The United States laboratory reported 45 four-plus, 1 negative and 4 anticomplementary samples.

Table V shows the complement-fixation test results obtained by both laboratories on 49 known negative anaplasmosis serum samples. The Maryland laboratory reported 4 three-plus, 3 two-plus, 1 one-plus, 37 negative and 4 anticomplementary

### TABLE III

**Numerical Values Assigned to the Various Types of Complement-Fixation Reactions**

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>4+</td>
</tr>
<tr>
<td>Positive</td>
<td>3+</td>
</tr>
<tr>
<td>Positive</td>
<td>2+</td>
</tr>
<tr>
<td>Positive</td>
<td>+</td>
</tr>
<tr>
<td>Negative</td>
<td>4+</td>
</tr>
<tr>
<td>Negative</td>
<td>3+</td>
</tr>
<tr>
<td>Negative</td>
<td>2+</td>
</tr>
<tr>
<td>Negative</td>
<td>+</td>
</tr>
<tr>
<td>Pos. or neg.</td>
<td>a.c. (both labs.)</td>
</tr>
<tr>
<td>Pos. or neg.</td>
<td>a.c. (one lab.)</td>
</tr>
</tbody>
</table>

**KEY:** a.c. = anticomplementary.

### TABLE IV

**Complement-Fixation Results on Known Positive Anaplasmosis Sera**

<table>
<thead>
<tr>
<th>Reaction</th>
<th>U. S. Test</th>
<th>Md. Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>4+</td>
<td>45</td>
<td>28</td>
</tr>
<tr>
<td>3+</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>2+</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>1+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>a.c.</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>
samples. The United States laboratory reported 49 negative samples. When these values shown in Table III were applied to the above-mentioned test results in Tables IV and V, the Maryland laboratory obtained a rating of 81.0 per cent accuracy and the United States laboratory was 97.9 per cent accurate. The results of this experiment shows that the United States complement-fixation testing method was 16.9 per cent more accurate than the Maryland method.

**DISCUSSION**

**Antigen Comparisons**

Any differences shown in Table I between the United States test and Maryland test for any one type of antigen produced from one donor animal are due almost entirely to a difference in testing technique (Table II) because the same testing reagents, except saline, were used in the same relative proportion by both laboratories. An average between the Maryland positive and the United States positive sera was used by both laboratories for figuring the number of antigen test units and corrections were made on Maryland test figures to compensate for the difference in the test volume. For example, the total volume of the Maryland test was 1.5 cc. and the total volume of the United States test was 5 cc. Therefore, for the purpose of comparison, the corrected antigen unit figures shown for the Maryland test were adjusted to a 5 cc. total test volume. Table I shows the United States antigen test unit is three to four times larger than the Maryland antigen test unit; however, either the United States test or the Maryland test may be used to demonstrate the potency value of the different type antigens as both tests showed the same relative difference between the antigen test units for the different types of antigens.

The Servall antigen production method was the most productive as 1.367 United States antigen test units were obtained from each cc. of blood as compared with 1.223 units by the Sharples method and .790 units by the CO₂ method. The production time in man hours for each 1000 cc. of blood processed was as follows: Servall method, 4.3 man hours; Sharples method, 2.4 man hours; and CO₂ method, 3.0 man hours.

On the basis of this comparison the Sharples method of production is the most economical. It is not the most productive but compares very favorably with the highest yielding process. Some other advantages in its favor are, it can be easily
adapted to large-scale production and other experiments have shown it to produce less anticomplementary material than produced by the CO₂ method. Additional information is needed on this type of antigen concerning pooling, storage, lyophilization, shipping, and how it is affected by preservatives.

The CO₂ antigen is less economical and less productive than the Sharples type antigen. It also contains more anticomplementary material and more color, thus making the tests more difficult to read than the other antigens. The present advantage of this type antigen is the abundance of information we have on the pooling, storage, lyophilization, preservation, shipping, and test accuracy qualities. This information was accumulated from ten years of research work and is of unlimited value on a testing program. The production of this type antigen will probably be replaced gradually by the Sharples type antigen as more information is accumulated after comparative studies.

The Servall method of production yields the most antigen and contains very little anticomplementary material, but it is not adaptable for large-scale production and is uneconomical to produce. The production process is very similar to the more desirable Sharples type antigen which has already replaced it in most experimental investigations.

Comparison of the United States and Maryland Complement-Fixation Tests

The accuracy of the United States test was 97.9 per cent and the Maryland test was 81.0 per cent using values as assigned in Table III, when measured on 50 positive (Table IV) and 49 negative (Table V) serum samples from animals of known status. It should be pointed out that the same test reagents, except saline, were used in the same relative proportions throughout both tests. Although no known explanation is available for the poor results obtained with the Maryland testing method, differences in interpretation may have played a role. Similar comparative testing studies on large numbers of samples obtained from animals with known histories are needed for the development of a standard testing procedure.

SUMMARY

1. A comparison of three types of anaplasmosis antigens designated as carbon dioxide precipitate antigen (CO₂ antigen), Servall distilled water extract antigen (Servall antigen), and Sharples distilled water extract antigen (Sharples antigen) produced from infective material from the same donor animals when tested by the United States Department of Agriculture and Maryland laboratories, both of which used the same testing reagents, showed each type of antigen was satisfactory for use. The production methods were compared for productivity, economy, and practical application. Productivity comparison, based on the number of test units obtained from one cc. of blood were Servall, 1.367 test units; Sharples, 1.223 test units; and CO₂ method, .790 test units.

Economy of production was based on man hours of work required for processing one liter of blood and were Sharples 2.4 man hours, CO₂ 3.0 man hours, and Servall 4.3 man hours. The practical application or summary comparison was made on the basis of productivity, economy, adaptability for large-scale production, anticomple-
mentary activity, test accuracy, and all other factors known about each method. On the above basis the production methods were ranked Sharples first, CO₂ second, and Servall third.

2. A comparison of two complement-fixation testing techniques, United States Department of Agriculture and Maryland, on 50 known positive and 49 negative bovine serum samples, where aliquots of the same testing reagents were used in the same relative proportion, resulted in 97.9 per cent accuracy for the United States test and 81.0 per cent accuracy for the Maryland test.

3. Interpretations of the test. Maryland interpretation of the test results would include in the positive group all animals showing a 2+ reaction or higher, 1+ are suspicious.

The United States interpretation of the test results includes in the positive group all animals showing a 3+ reaction or higher, 2+ and 1+ are suspicious.

Acknowledgments. The authors wish to express their appreciation to Dr. T. O. Roby for his suggestions and for testing serum samples in the United States laboratory. We also wish to express our appreciation to Mr. Arnold C. Johnson, serologist at the Maryland Livestock Sanitary Service laboratory, for testing serum samples.

REFERENCES


REPORT OF COMMITTEE ON ANAPLASMOSIS

A. L. Brueckner, Baltimore, Maryland, Chairman; J. A. Acree, Jacksonville, Florida; V. D. Chadwick, Jackson, Mississippi; J. A. King, Phoenix, Arizona; F. R. Koutz, Columbus, Ohio.

Your Committee on Anaplasmosis has little to report beyond the papers which have been presented on this subject.

The work on antigen preparation and complement fixation testing has progressed to the point where field investigations in a number of states are indicated. Your Committee suggests that officials in states in which this disease is a problem avail themselves of the opportunity of setting up diagnostic facilities in their laboratories for the purpose of testing for this disease. It is equally important that other states do the same, in order to be able to determine the presence or absence of the disease within their boundaries.
THE INCIDENCE OF ANTHRAX IN LIVESTOCK DURING 1953 AND THE FIRST THREE QUARTERS OF 1954

C. D. STEIN, V.M.D.*

The data presented in this report are based chiefly on the information contained in the monthly reports on the incidence of anthrax in livestock submitted to the Animal Disease and Parasite Research Branch of the Agricultural Research Service by the livestock sanitary officials of the different States and territories.

Figures computed from these reports (1) show that during 1953 there were 233 anthrax outbreaks in animals reported from 26 States involving 121 counties with livestock losses of 409 cattle, 127 swine, 51 sheep, 8 horses, and 2 mules (Table I).

Aside from widespread outbreaks that occurred in Clay, Wayne, and Richland counties in the southeastern part of Illinois, and an increase in sporadic outbreaks in South Dakota, 1953 can be considered an average anthrax year. Although outbreaks were reported from 37 counties which had no recorded previous history of the disease, the majority of the outbreaks were sporadic, and occurred in recognized anthrax areas, involving chiefly cattle with small losses.

Outbreaks in sheep were reported from California with a loss of 27 head and from Illinois with a loss of 24 animals. Minnesota reported an outbreak in a minkery with a loss of 86 mink.

Puerto Rico reported three outbreaks with a loss of four cattle.

The suspected sources of infection reported in connection with the 1953 outbreaks were as follows: Infected soil 45 per cent; contaminated feed 3 per cent, and unknown 52 per cent. This shows the need for further research to obtain more definite information on the source and spread of anthrax infection in new areas. Of the 233 outbreaks reported in 1953, 199 were confirmed by laboratory examination (Table I).

Records of the Meat Inspection Branch for 1953 show that at establishments operating under Federal meat inspection, 54 hogs and no cattle were condemned for anthrax.

The United States Public Health Service (2) reported a total of 45 cases in man for 1953.

OUTBREAKS IN 1954

Data compiled from the monthly anthrax reports for the first 9 months of 1954 reveal that during this period 388 outbreaks were reported from 21 States with a loss of 1580 cattle, 122 swine, 321 horses, 103 sheep, 24 wild animals kept in captivity, and one deer (Table II, Table III, Graph 1).

With the exception of the outbreaks of a severe nature involving heavy losses of livestock that occurred in southeastern Louisiana and southwestern Mississippi, most of the outbreaks were sporadic and involved principally cattle with small losses.

* Animal Disease and Parasite Research Branch, Agricultural Research Service, Washington, D. C.
### TABLE I

**States Reporting Anthrax Outbreaks in Livestock in 1963 and Data on Incidence**

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cattle</td>
<td>Swine</td>
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<tr>
<td>Arkansas</td>
<td>3</td>
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<tr>
<td>California</td>
<td>7</td>
<td>11</td>
<td>18</td>
<td>—</td>
<td>27 sheep</td>
</tr>
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<td>8</td>
<td>—</td>
<td>—</td>
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<tr>
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<tr>
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<td>2</td>
<td>2</td>
<td>1</td>
<td>—</td>
</tr>
</tbody>
</table>

|               | 26           | 121           | 233    | 409   | 127   | 597   | 104  | 8    | 121  |
|               |             |               | 51 sheep | 8 horses | 86 mink | 2 mules |       |      |

* Data based on corrected monthly reports on incidence.

† A post vaccination case.

‡ Does not include 86 mink.

§ Based on clinical diagnosis.

### OUTBREAKS IN LOUISIANA AND MISSISSIPPI

Anthrax control is an old problem in Louisiana. The disease has existed in this State since its early settlement by the French. Outbreaks have been reported from all the counties in the State except nine.
TABLE II

Monthly Incidence of Anthrax in Animals for the First Three Quarters of 1964

<table>
<thead>
<tr>
<th>Month</th>
<th>No. States Reported</th>
<th>No. Outbreaks Reported</th>
<th>Livestock Losses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cattle</td>
</tr>
<tr>
<td>January</td>
<td>3</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>February</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>March</td>
<td>9</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td>April</td>
<td>5</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>May</td>
<td>6</td>
<td>19</td>
<td>31</td>
</tr>
<tr>
<td>June</td>
<td>8</td>
<td>22</td>
<td>35</td>
</tr>
<tr>
<td>July</td>
<td>8</td>
<td>263</td>
<td>1020</td>
</tr>
<tr>
<td>August</td>
<td>9</td>
<td>29</td>
<td>241</td>
</tr>
<tr>
<td>September</td>
<td>9</td>
<td>25</td>
<td>217</td>
</tr>
<tr>
<td>Totals</td>
<td>*</td>
<td>388</td>
<td>1,580</td>
</tr>
</tbody>
</table>

* A total of 21 different States reported outbreaks.
† 3 cougars, 14 raccoons, 3 bobcats, 2 badgers, and 2 coati mundi lost in zoo outbreak.
‡ 1 deer.

Severe epizootics of the disease in domestic animals are recorded as having occurred between 1834 and 1850; 1895 and 1902; 1920 and 1925, and in 1943 (3). During the last decade major outbreaks involving numerous premises with heavy losses of livestock occurred in 1946 and 1948.

According to Heeren (4) the incidence of human anthrax in Louisiana is comparatively high, 111 cases being reported from 1920 to 1945. Most of these cases appeared to be of agricultural origin since they occurred in areas where the disease was prevalent in livestock.

The area south of New Orleans in which the widespread outbreaks of anthrax occurred in June, July, and August, 1954, involves three parishes; Jefferson, Saint

TABLE III

Incidence of Anthrax for First Three Quarters of 1964

<table>
<thead>
<tr>
<th>Period</th>
<th>No. States Reporting</th>
<th>No. Outbreaks</th>
<th>Live stock Losses</th>
<th>Source of Infection</th>
<th>Laboratory Confirmed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Soil</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>First quarter</td>
<td>10</td>
<td>22</td>
<td>36</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Second quarter</td>
<td>11</td>
<td>49</td>
<td>78</td>
<td>48</td>
<td>1</td>
</tr>
<tr>
<td>Third quarter</td>
<td>17</td>
<td>317</td>
<td>2012</td>
<td>313</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>21†</td>
<td>388</td>
<td>2126</td>
<td>371</td>
<td>17</td>
</tr>
</tbody>
</table>

* 24 zoo animals not included.
† Different States.
Bernard, and Plaquemines. The area varies in width and extends along the banks of the lower Mississippi River for about 90 miles. The general elevation is very low, varying from two to twenty-five feet above sea level; although the river is retained in its channel by levees throughout most of this area, much of the terrain, which consists of low, marshy land including many lakes, bayous, and canals, is inaccessible by road and subject to overflow. In some sections of the area, especially near the mouth of the river, the cattle pastures are composed of comparatively narrow strips of natural levee beyond which are marshlands. (See map.)

The last severe epizootic occurred in this area about 20 years ago, and since the disease had not been a problem for the past several years, most of the cattle owners had neglected to vaccinate against anthrax. A long period of dry weather followed by frequent rains and extremely hot weather together with a great increase in the number of biting flies, mosquitoes, and other insects appeared to favor the occurrence and spread of anthrax in this area.

The outbreaks in this area had about subsided when a second focus of infection of a less severe nature appeared during the latter part of August north of Lake Pontchartrain near Slidell in St. Tammany Parish. During September a number of additional outbreaks with a heavy loss of cattle occurred in an old endemic area in Lafourche Parish, and recurrence of anthrax was reported in Jefferson parish, where a number of recently vaccinated animals developed the disease. During 1954 sporadic outbreaks occurred in at least eight additional parishes in Louisiana. Losses of livestock from anthrax in Louisiana during July, August, and September were reported as follows: 1,337 cattle; 208 horses; 109 swine; and three sheep.

A sharp outbreak of anthrax also occurred during the latter part of July and August in Hancock County in southwestern Mississippi, just across the Pearl River from the Slidell anthrax area in St. Tammany Parish, Louisiana. Reported losses
of livestock in this area were 60 cattle; eight horses; 100 sheep; and one hog. Sporadic outbreaks with minor losses occurred in at least seven additional counties in Mississippi.

The outbreaks in southeastern Louisiana, and southwestern Mississippi had many features in common. The type of terrain was similar, climatic conditions were identical, and both areas were subject to flooding.

Quarantine, wide-scale vaccination, and other sanitary police measures were employed by state livestock sanitary officials of Louisiana and Mississippi to combat the spread of the infection. In Louisiana, at least 26,500 head of livestock were vaccinated against anthrax during July, August, and September. Recent reports received from this area indicate that losses from anthrax have subsided and that the disease is well under control. (See map.)

OUTBREAK OF ANTHRAX IN ZOO ANIMALS

An unusual outbreak of anthrax was reported during June 1954 among carnivorous animals in the Woodland Park Zoo in Seattle, Washington, due to feeding meat from a zoo pony that died suddenly without showing any symptoms suggestive of anthrax.

A post-mortem examination performed on the pony by the zoo veterinarian failed to reveal an enlarged spleen or other pathological alterations of the abdominal organs indicative of anthrax. However, the superficial pectoral muscles and surrounding tissues were edematous and infiltrated with a yellow gelatinous fluid resembling a bruise. The heart was hemorrhagic and a clot was observed at the junction of the aorta and pulmonary artery. These findings suggested that the
INCIDENCE OF ANTHRAX IN LIVESTOCK

A pony died from shock caused by a severe blow in the pectoral region. In accordance with the practice at the zoo in accident cases, the carcass was butchered and fed to about 60 meat-eating animals. Four to six days later, 24 of the zoo animals including three cougars, 14 raccoons, three bobcats, two coati mundi, and two badgers died of an unknown condition, which was later determined to be anthrax on laboratory examination. Six additional felines showing early symptoms of anthrax and all the lions, tigers, leopards, and other exposed felines were treated with terramycin or penicillin and no further losses occurred. It was also reported that an outbreak of anthrax occurred in a herd of Japanese Sika Deer in the same Seattle Zoo 21 years ago. However, the pony that died in the recent outbreak was reported to have had no contact with the area in which the outbreak in deer occurred.

In this connection, it should be pointed out that a number of cases of atypical anthrax have been reported in horses where lesions are confined to the throat and neck. These cases showed edematous infiltration of the subcutaneous and intramuscular tissue and glands in the throat region with usually no involvement of the digestive tract, liver, spleen, and kidneys. Several cases of this type were reported by McNellis (5) in an outbreak that occurred in a large number of Peruvian army horses that were kept on an infected pasture.

Additional outbreaks in zoo animals in the United States occurred in Herman Park Zoological Gardens, Houston, Texas, in 1941 (3) and in the Highland Park Zoo, Pittsburgh, Pennsylvania, in 1947 (6).

A number of outbreaks among mink held in captivity have also been reported in the United States (7). Such outbreaks were reported from Colorado, Missouri, and Oregon in 1939, from New York in 1941 and 1952, from Wisconsin in 1952 and 1953, from New Jersey in 1952, and from Minnesota in 1953. The source of the infection in all of the outbreaks in minkeries was traced to feeding contaminated meat.

In England an outbreak in elephants was reported in the London Zoo (8) and an outbreak involving several species of wild animals was reported in a travelling menagerie (9). A similar outbreak in a menagerie, in which two lions, two pumas, and a bear died of anthrax, was reported from Germany in 1908 (10).

Spontaneous outbreaks in wild animals under natural conditions have been reported in wild pigs, wild dogs, and dingoes in Australia (11); in deer in California, Florida, Louisiana, and Texas. In elephants in India, Siam, and Burma (8, 12); in wolves, hares, and elk in Russia (13); and in antelope and ostriches in South Africa (14). The camel, kangaroo, water bison, and reindeer are also susceptible to anthrax and a number of cases have been reported in farm dogs and cats.

REFERENCES

A STUDY OF FACTORS THAT INFLUENCE THE ISOLATION AND GROWTH OF BRUCELLA IN OR ON CULTURE MEDIUMS

I. Forest Huddleston*

East Lansing, Michigan

It has been recognized for many years by those concerned with the detection of brucellosis in humans and in animals that its ultimate diagnosis depends upon the isolation of the Brucella on laboratory culture medium. The interpretation of the results of diagnostic tests in both animals and humans must first be formulated from culture findings. And in the case of human brucellosis, it is often not possible to arrive at a diagnosis without positive culture findings as the results of other diagnostic methods are frequently not too significant.

Several supposedly satisfactory liquid and agar mediums have been in use for several years and a few new ones have come into wide use since World War II. In view of this situation it might seem elementary to many at this period of the evolution of our knowledge of brucellosis to be expending efforts in the investigation of culture mediums and procedures for the isolation and growth of the Brucella.

The question might then be asked, "Are the culture mediums and the procedures for their use as satisfactory as would appear on the surface and need little or no further study for improvement?" This question has been answered in the results of studies conducted by the writer during the past three years. Several culture mediums, as they are now prepared, were found unsatisfactory for certain purposes. The principal objectives in these studies were to gain more knowledge of the factors influencing the isolation and growth of the Brucella, such as medium constituents and the physio-chemical conditions under which the inoculated mediums are incubated.

In the studies designed to determine the comparative value of liquid and agar culture mediums for the isolation of Brucella, strains of an atypical, CO₂-dependent type of Brucella abortus were employed. Cells of this type do not grow well or at all on some of the culture mediums now being employed for the isolation and growth of Brucella. This is especially noticeable when the inoculum contains less than 500 living cells. Strains of this type, identified as type II (Wilson) have been isolated from humans in the United States and Great Britain, from the milk of cows in one herd in Michigan (1), and an aborted fetus in Indiana (2).

PROCEDURES WITH LIQUID MEDIUMS

The mediums employed in these studies were beef liver, potato infusion, tryptose, peptone M, and trypticase soy. With the exception of liver and potato, they were prepared either from lots of pre-mixtures of the manufacturers or from the constituents recommended by the manufacturers. The two exceptions were first prepared according to formulas previously described (3, 4). As the studies pro-

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gressed, changes were made in the formulas as indicated from the results of experiments.

The mediums were distributed in 20 ml. amounts into 50 ml. serum bottles. The bottles were plugged with absorbent cotton and autoclaved according to the recommended procedures. The mediums were inoculated and incubated according to a procedure described previously (5).

Inoculum. The member of living cells added to the mediums varied between five and 60. It was thought that if a culture medium or a procedure was suitable for the rapid multiplication of a small number of cells that might conceivably be present in tissues or fluids from naturally infected animals or humans, the same medium would also promote rapid growth when large numbers of brucella cells were present. Furthermore, it was logical to assume, and later confirmed, that any medium and procedure that was satisfactory for the isolation of a fastidious strain of Br. abortus would also be ideal for the isolation of typical strains of this and other species of Brucella.

All mediums prepared according to the recommended formulas failed to initiate growth of the type II strain of Br. abortus that was visible to the eye during a three-day incubation period at 37°C. This length of time was considered sufficient for evaluating the growth-promoting property of each of the mediums. The negative results led to a study of the effect of adjusting the pH with different agents and the CO₂ concentration in closed jars on the growth of brucella cells.

RESULTS

Effect of pH of medium and concentration of CO₂ on growth. The agents used for adjusting the H-ion concentration of the culture mediums were NaHCO₃, Na₂CO₃, NaOH, and K₂HPO₄. Sodium bicarbonate was used not only as a means of controlling the pH but, in addition, as a source of CO₂ when the medium containers were sealed.

The method used for controlling the pH and quantity of CO₂ with NaHCO₃ follows: A 0.9 M solution of NaHCO₃ (C.P.) was prepared in distilled water (25°C.) and sterilized by filtering through a D8 Hormann pad in a Seitz filter. A fresh solution was prepared within one hour of its addition to the mediums (20°C.). The amounts of the solution to be added to the bottles of sterile medium (pH 6.8–6.9) to obtain different initial pH levels were determined on a sample of the medium by means of a glass electrode pH meter. Shortly after adding the inoculum (suspension of cells diluted to contain 30–100 cells/ml.), the required amount of bicarbonate solution was measured into each bottle, and the bottles were either sealed (rubber stopper) within two minutes or placed in jars for the addition of CO₂, depending on the nature of the experiment. All containers were incubated at 37°C. and examined daily for three days for the appearance of visible turbidity. At the end of the third day, the pH of each bottle of medium was determined (20°C.) as previously mentioned, and the degree of turbidity, if any, measured in a photron-reflectometer. Scale readings were converted into an approximate total cells/ml.

Data representative of the many experiments performed to determine the effect of pH adjustment with different agents and the effect of different concentrations of CO₂ on growth in trypticase soy medium are set forth in Table 1. It may be noted that the initial pH of the medium and the concentration of CO₂ in the atmos-
### TABLE 1

*Effect of pH Adjustment and Concentration of CO₂ on Growth of a CO₂ Dependent Strain of Br. abortus in Liquid Medium*

<table>
<thead>
<tr>
<th>pH Adjustment and Agents Used&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Inoc. Cells Added&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Incubation, 72 Hours at 37°C.</th>
<th>Atmosphere</th>
<th>Turbidity&lt;sup&gt;e&lt;/sup&gt;</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.9 (none)</td>
<td>20</td>
<td></td>
<td></td>
<td>5</td>
<td>6.5</td>
</tr>
<tr>
<td>7.1 (NaHCO₃)</td>
<td>21</td>
<td>3</td>
<td>3+</td>
<td>7.45</td>
<td></td>
</tr>
<tr>
<td>7.1 (NaHCO₃)</td>
<td>20</td>
<td>5</td>
<td>3+</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>7.1 (NaHCO₃)</td>
<td>12</td>
<td>3</td>
<td>3+</td>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td>7.4 (NaHCO₃)</td>
<td>30</td>
<td>3</td>
<td>3+</td>
<td>7.9</td>
<td></td>
</tr>
<tr>
<td>7.4 (NaHCO₃)</td>
<td>20</td>
<td>5</td>
<td>3+</td>
<td>7.7</td>
<td></td>
</tr>
<tr>
<td>7.4 (NaHCO₃)</td>
<td>12</td>
<td>10</td>
<td>3+</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>7.1 (NaHCO₃)</td>
<td>20</td>
<td>5</td>
<td>3+</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>7.4 (NaHCO₃)</td>
<td>20</td>
<td>Sealed&lt;sup&gt;f&lt;/sup&gt;</td>
<td>5+</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>7.2 (Na₂CO₃)</td>
<td>12</td>
<td>3</td>
<td>-</td>
<td>6.8</td>
<td></td>
</tr>
<tr>
<td>7.4 (Na₂CO₃)</td>
<td>12</td>
<td>3</td>
<td>3+</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>8.0 (Na₂CO₃)</td>
<td>12</td>
<td>3</td>
<td>3+</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>7.1 (Na₂CO₃)</td>
<td>20</td>
<td>3</td>
<td>2+</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>7.1 (Na₂CO₃)</td>
<td>20</td>
<td>5</td>
<td>-</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>7.1 (Na₂CO₃)</td>
<td>20</td>
<td>10</td>
<td>-</td>
<td>6.6</td>
<td></td>
</tr>
<tr>
<td>7.4 (Na₂CO₃)</td>
<td>20</td>
<td>3</td>
<td>1+</td>
<td>7.2</td>
<td></td>
</tr>
<tr>
<td>7.4 (Na₂CO₃)</td>
<td>20</td>
<td>5</td>
<td>4+</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>7.4 (Na₂CO₃)</td>
<td>20</td>
<td>10</td>
<td>1+</td>
<td>6.8</td>
<td></td>
</tr>
<tr>
<td>8.0 (Na₂CO₃)</td>
<td>12</td>
<td>3</td>
<td>3+</td>
<td>7.4</td>
<td></td>
</tr>
<tr>
<td>8.0 (Na₂CO₃)</td>
<td>30</td>
<td>5</td>
<td>4+</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>8.0 (Na₂CO₃)</td>
<td>30</td>
<td>10</td>
<td>3+</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>7.1 (NaOH)</td>
<td>30</td>
<td>3</td>
<td>-</td>
<td>6.8</td>
<td></td>
</tr>
<tr>
<td>7.4 (NaOH)</td>
<td>30</td>
<td>3</td>
<td>1+</td>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td>7.4 (NaOH)</td>
<td>20</td>
<td>5</td>
<td>-</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>8.0 (NaOH)</td>
<td>21</td>
<td>3</td>
<td>2+</td>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td>8.0 (NaOH)</td>
<td>21</td>
<td>5</td>
<td>3+</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>7.3 (K₂HPO₄)&lt;sup&gt;o&lt;/sup&gt;</td>
<td>21</td>
<td>3</td>
<td>2+</td>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td>7.3 (K₂HPO₄)&lt;sup&gt;o&lt;/sup&gt;</td>
<td>30</td>
<td>5</td>
<td>-</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>7.3 (K₂HPO₄)&lt;sup&gt;o&lt;/sup&gt;</td>
<td>28</td>
<td>10</td>
<td>-</td>
<td>6.7</td>
<td></td>
</tr>
</tbody>
</table>

* Trypticase soy formula, 20 ml. in 50 ml. bottles.
* Agent added at time of inoculation unless indicated.
* Added before autoclaving.
* Added before autoclaving.
* Agar plate colony count.
* Added to closed glass jars.
* Closed with rubber stopper after adjusting pH.
* − = no turbidity. 1-5+ = degree of growth.

The atmosphere of the containers were important factors influencing the extent of cell multiplication. The concentration of CO₂ in the containers controlled the pH level of the medium during the period of incubation. If the initial pH was low and the concentration of CO₂ high, the pH of the medium during incubation descended.
below the level that was optimum for cell multiplication. Cell multiplication occurred in the culture medium with concentrations of CO₂ varying between three and ten per cent provided the initial pH of the medium was adjusted to the proper level. Two agents, namely NaOH and K₂HPO₄, were not satisfactory for adjusting the pH level of mediums for growth of the fastidious strain of Br. abortus.

The other liquid mediums mentioned earlier were studied in the same manner as trypticase soy. All failed to show visible growth in 72 hours until the composition of the mediums were altered.

While it would appear from the results presented in Table 1 that rapid growth of Br. abortus cells does not occur in liquid medium at low pH levels, data to be presented later on in this paper show multiplication of cells does occur at a low pH level when the composition of the medium is altered.

Effect of additives in tryptose broth on growth of brucella cells. Data were presented in two previous papers (5, 6) which showed that tryptose broth as it is now prepared was not a satisfactory medium for growing small numbers of the type II strain of Br. abortus and that this deficiency could be corrected by adding a sterile, sonically prepared extract from Br. suis or Micrococcus aureus to the medium. The extracts either supplied a growth stimulatory agent which was not present to any extent in the medium or suppressed the action of a bacteriostatic agent in the medium.

The data set forth in Table 2 illustrate the remarkable change that occurred in the growth of cells in tryptose broth in the presence of a bacterial cell extract, blood serum, or serum albumin. The addition of aged blood serum or serum albumin (crystalized) in sufficient concentration to any of the deficient mediums had a growth stimulatory effect on type II Br. abortus cells similar to that of bacterial

<table>
<thead>
<tr>
<th>Agent Added, Amount</th>
<th>pH ²</th>
<th>Inoc. Cells Added ³</th>
<th>Incubation at 37°C.</th>
<th>pH, ⁷² hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>48 hours</td>
<td>72 hours</td>
</tr>
<tr>
<td>Cell extract, 0.5 ml.</td>
<td>7.1</td>
<td>30</td>
<td>2+</td>
<td>4+</td>
</tr>
<tr>
<td>Cow serum, 0.1 ml.</td>
<td>7.1</td>
<td>20</td>
<td>2+</td>
<td>4+</td>
</tr>
<tr>
<td>Serum albumin, 0.1 ml.</td>
<td>7.1</td>
<td>20</td>
<td>2+</td>
<td>4+</td>
</tr>
<tr>
<td>None</td>
<td>7.2</td>
<td>30</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

² 20 ml. medium in 50 ml. bottles.
³ 1 ml. of extract represents approximately 10¹⁰ brucella cells (S-type).
⁴ Protein, 8 per cent.
⁵ 5 per cent solution of crystallized albumin.
⁶ Adjusted with NaHCO₃ and sealed at time of inoculation.
⁷ Agar plate colony count, Br. abortus type II.
⁸ — = no turbidity; 2-4+ = degree of growth.
TABLE 3

Effect of Blood Serum and Serum Albumin on Bacterial Growth in Mediums of Different Initial pH Levels

<table>
<thead>
<tr>
<th>Medium</th>
<th>Initial pH</th>
<th>Agent Added, Final Conc., Per Cent</th>
<th>Inoc. Cells Added</th>
<th>Incubation at 37°C, 72 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Atmosphere</td>
</tr>
<tr>
<td>T-soy</td>
<td>7.5</td>
<td>None</td>
<td>27</td>
<td>5% CO₂</td>
</tr>
<tr>
<td>T-soy</td>
<td>6.9</td>
<td>None</td>
<td>27</td>
<td>5% CO₂</td>
</tr>
<tr>
<td>T-soy</td>
<td>6.9</td>
<td>Cow serum, 0.25</td>
<td>27</td>
<td>5% CO₂</td>
</tr>
<tr>
<td>T-soy</td>
<td>6.9</td>
<td>Serum albumin, 0.1</td>
<td>27</td>
<td>5% CO₂</td>
</tr>
<tr>
<td>Tryptose</td>
<td>7.0</td>
<td>None</td>
<td>27</td>
<td>5% CO₂</td>
</tr>
<tr>
<td>Tryptose</td>
<td>7.0</td>
<td>Cow serum, 0.25</td>
<td>27</td>
<td>5% CO₂</td>
</tr>
<tr>
<td>Tryptose</td>
<td>7.0</td>
<td>Serum albumin, 0.1</td>
<td>27</td>
<td>5% CO₂</td>
</tr>
<tr>
<td>Tryptose</td>
<td>7.5</td>
<td>None</td>
<td>27</td>
<td>5% CO₂</td>
</tr>
<tr>
<td>Tryptose</td>
<td>7.5</td>
<td>Cow serum, 0.25</td>
<td>27</td>
<td>5% CO₂</td>
</tr>
</tbody>
</table>

* Adjustment made with Na₂CO₃.
* Br. abortus type II.
* - = no turbidity; + = degree of turbidity.

cell extracts. Medium without the added agents showed no visible growth at the end of 72 hours incubation.

Effect of blood serum and serum albumin on bacterial growth in liquid mediums adjusted to different pH levels. The data presented in Table 1 showed that liquid mediums at initially low pH levels were lowered further when placed in atmospheres containing three to ten per cent CO₂. A decrease in growth of CO₂-dependent cells of Br. abortus paralleled the decrease in pH. The results presented in Table 3 show that growth in trypticase soy medium at a low pH level was not delayed when either cow serum or crystalline albumin in low concentrations were present. On the other hand, growth in the other medium, tryptose, did not occur until the initial pH was raised. The results show that the pH level of liquid mediums within a certain range is an important factor in retarding cell growth when the medium is deficient in a growth-stimulatory agent.

Growth of brucella cells in liquid mediums in the presence of whole blood. The culture method found satisfactory for initiating the rapid growth of Br. abortus type II in liquid medium proved inadequate in the presence of whole blood from humans, cows, rabbits, and guinea pigs. An extensive study (5) of the possible factors that promote or delay the growth of brucella cells in the presence of whole blood revealed that at least five factors were involved. The two principal ones that were found to interfere with the multiplication of small numbers of brucella cells in liquid medium in the presence of blood were 1 the bactericidal antibody-complement system and 2 the glycolytic action of red cells by which glucose in the blood is degraded to fatty acids.

The role played by the bactericidal antibody-complement system in preventing the isolation of Brucella from the blood of infected humans and cows has been
known since 1935 (7, 8). Studies (5) have revealed that the presence of $2 \times 10^9$ killed brucella cells/ml in the culture medium was sufficient to inactivate the brucella antibody-complement system in 5 ml of animal or human blood. S-type brucella cells were added to the medium just before autoclaving.

Aerobic and anaerobic glycolysis by red cells has been studied for many years (9, 10, 11). When glycolysis occurs in a culture medium to which blood is added for the purpose of culturing *Brucella*, the pH may fall below that which is optimum for growth. However, by raising the initial pH with Na$_2$CO$_3$ before adding blood, the acid produced by glycolysis is partially neutralized and carbon dioxide is released from the carbonate. The containers must be sealed (rubber stoppers) after the addition of blood to the medium in order to retain the CO$_2$ that accumulates, as it is essential for the growth of CO$_2$-dependent strains. By employing the procedure just mentioned, it is obvious that glass jars and various methods for obtaining CO$_2$ are no longer necessary for isolating *Brucella* from blood.

The results presented in Table 4 illustrate the effect of the factors previously mentioned on the growth of brucella cells in one liquid medium in the presence of fresh cow blood. The procedure used for collecting the blood and inoculating the medium has been described previously (5). Growth of brucella cells occurred during three days of incubation only in the containers in which the bactericidal-antibody-complement system was inactivated by the presence of a specific antigenic material. Rapid growth occurred after the removal of plasma from the red cells. The fresh plasma alone inhibited growth. The results presented were confirmed many times with blood taken from three cows as well as from five humans.

TABLE 4

Effect of Normal Cow Blood and Killed Brucella Cells on Bacterial Growth in Liquid Medium

<table>
<thead>
<tr>
<th>Medium*</th>
<th>pH, Agent Used*</th>
<th>Blood or 4 Plasma</th>
<th>Incoc. Cells Added*</th>
<th>Incubation 72 Hours at 37°C.</th>
<th>Atmospheric</th>
<th>Growth*</th>
<th>pHh</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>7.1 (None)</td>
<td>Whole blood</td>
<td>25</td>
<td>5% CO$_2$</td>
<td>-</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>7.8 (Na$_2$CO$_3$)</td>
<td>Whole blood</td>
<td>25</td>
<td>5% CO$_2$</td>
<td>-</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>7.8 (Na$_2$CO$_3$)</td>
<td>Whole blood</td>
<td>10</td>
<td>Sealed*</td>
<td>4+</td>
<td>7.2</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>7.8 (Na$_2$CO$_3$)</td>
<td>Whole blood</td>
<td>25</td>
<td>5% CO$_2$</td>
<td>4+</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>7.8 (Na$_2$CO$_3$)</td>
<td>Plasma</td>
<td>20</td>
<td>5% CO$_2$</td>
<td>-</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>7.8 (Na$_2$CO$_3$)</td>
<td>Red cells</td>
<td>20</td>
<td>5% CO$_2$</td>
<td>4+</td>
<td>6.8</td>
<td></td>
</tr>
</tbody>
</table>

* Trypticase soy formula + 0.5 per cent sodium citrate.

b $2 \times 10^9$ cells/ml. *Br. abortus* added before autoclaving.

c pH of medium after adding blood or plasma.

d 5 ml of whole blood, plasma, or red cells from 5 ml of fresh blood.

e Plate colony count, *Br. abortus* type II.

f Bottle closed with rubber stopper.

- = no growth; 4+ = $>10^6$ colonies/ml.

h pH of medium at 72 hours.
PROCEDURES AND RESULTS WITH AGAR MEDIUMS

It has been an observation of the writer for some years that most of the agar mediums that were highly satisfactory for the isolation of Brucella or for colonial studies were not always suitable for the production of large numbers of brucella cells. On the other hand, those that produced copious growth of cells had undesirable properties for colonial studies. In certain instances, it was found that by changing the recommended formulas of the mediums, their cell productiveness could be increased or colonial growth improved.

The agar mediums employed in the comparative study were 1 beef liver, 2 potato, 3 tryptose, 4 peptone M, and 5 trypticase soy. With the exception of 1 and 2, they were prepared according to the formula recommended by the manufacturers. The procedure and formula previously employed in the preparation of beef liver agar and of potato agar were altered during the course of the study to improve their growing properties and obtain mediums free from sediment.

Growth of Brucella in colonial form. All of the agar culture mediums, with one exception that were employed in this investigation were judged suitable for growing all typical strains of Brucella, including Codependent ones, in colonial form provided the pH of each was adjusted to the proper level. The one exception was beef liver agar. This medium, when prepared according to a previously described method, was not satisfactory for growing any strain of Br. abortus in isolated colonies.

Various experiments were performed to find an agent which when added to liver agar would permit rapid and satisfactory colonial growth of Br. abortus as well as the other species of Brucella. Either of two agents was found to improve the growing property of the mediums beyond expectations. By the addition of either NaHSO₃ or Na₂S₂O₆ to liver agar to a final concentration of 0.05 per cent at the time of autoclaving and by adjusting the pH of the medium to 7.2 with Na₂CO₃ after autoclaving, a medium was obtained that promoted colonial growth of all species and types of Brucella, including the fastidious type II, more rapidly than the other mediums employed in this study.

All the agar culture mediums examined, with the exception of two, were found unsatisfactory for growing 500 or less cells of Br. abortus type II (Wilson) in colonial form (12). The importance of knowing that most of the agar culture mediums now employed for the isolation of Br. abortus from infective materials are either deficient in a growth promoting agent or contain a growth inhibitory agent for this particular strain has not been fully appreciated.

Studies have revealed that the agar mediums which failed to support colonial growth of type II Br. abortus were converted into highly satisfactory ones by the presence of $2 \times 10^4$/ml. of killed cells of one of many bacteria (Br. abortus, Salmonella typhosa, Salmonella pullorum, Brucella bronchisepticus, Micrococcus aureus). The growth deficiency of the mediums was also corrected by the presence of either aged blood serum (0.2 per cent) or crystalline serum albumin (0.02 per cent). The latter agents must be added to the cooled mediums just before pouring agar plates. When the agar plates are to be incubated in an atmosphere of five per cent CO₂ the final pH should be 7.4–7.5.
Comparison of agar culture mediums for mass growth of brucella cells. The necessity of employing an agar culture medium that is capable of producing a large yield of brucella cells from a given surface area is quite obvious to those interested in the production of antigens and vaccines, or in obtaining large quantities of cells for biochemical studies.

Since it has been observed by those who have used potato agar that an occasional lot of the medium failed to grow brucella cells as well as others, it was thought that the variation in growing properties might be due to differences in the chemical composition of different varieties of potatoes or to differences in chemical composition brought about by the type of soil in which they were grown. In order to determine whether the variety of potato, the location of growth, or the type of soil on which they were grown affected the growth property of potato agar medium, infusion broth was prepared from the following varieties of potatoes:

<table>
<thead>
<tr>
<th>Variety</th>
<th>Place of Growth</th>
<th>Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sebago</td>
<td>Michigan</td>
<td>Sandy loam</td>
</tr>
<tr>
<td>Pontiac</td>
<td>Michigan</td>
<td>Sandy loam</td>
</tr>
<tr>
<td>Kennebec</td>
<td>Michigan</td>
<td>Sandy loam</td>
</tr>
<tr>
<td>Green mountain</td>
<td>Michigan</td>
<td>Sandy loam</td>
</tr>
<tr>
<td>Russet rural</td>
<td>Michigan</td>
<td>Sandy loam</td>
</tr>
<tr>
<td>Russet Burbank</td>
<td>Michigan</td>
<td>Muck</td>
</tr>
<tr>
<td>Triumph</td>
<td>Idaho</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>Florida</td>
<td>?</td>
</tr>
</tbody>
</table>

* Harvested in autumn.

b Harvested in spring.

In addition to potato broth, each agar medium contained sodium chloride, dextrose, glycerol, and meat extract according to a formula recommended by Cotton (3) of the United States Bureau of Animal Industry. Potato agar mediums were also prepared without glycerol and meat extract.

Inoculation of agar mediums. Two S strains of each of the three species of Brucella were used in the study. Cells grown for 24-48 hours on peptone-M agar were suspended in distilled water and standardized by means of a turbidometric method to contain approximately $2 \times 10^9$ living cells/ml. One ml. of the suspension was added to each of two agar plates of each medium and washed over the surface for five minutes; the excess liquid was then removed.

The inoculated agar plates were incubated at $37^\circ$C. for 72 hours at end of which time the growth was washed from their surfaces by adding distilled water and rubbing the growth into suspension with a small cotton-swab applicator. A measured amount of the total volume of each suspension thus obtained was diluted to a density (determined by electronic densitometer) equal to that produced by $2 \times 10^9$ cells/ml. The total number of cells obtained from each plate was calculated and the results recorded in billions/ml.

Comparison of yields of bacterial cells on different agar mediums. The results
TABLE 5
Comparison of Total Yield of Cells from Growth of Aerobic Strains of the Three Species of Brucella on Different Agar Mediums

<table>
<thead>
<tr>
<th>Medium</th>
<th>pH</th>
<th>Br. abortus</th>
<th>Br. melitensis</th>
<th>Br. suis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tryptose</td>
<td>6.9</td>
<td>351</td>
<td>269</td>
<td>416</td>
</tr>
<tr>
<td>Trypticase-soy</td>
<td>7.3</td>
<td>269</td>
<td>416</td>
<td>1,077</td>
</tr>
<tr>
<td>Peptone M</td>
<td>6.9</td>
<td>416</td>
<td>269</td>
<td>1,077</td>
</tr>
<tr>
<td>Peptone M + e</td>
<td>6.9</td>
<td>416</td>
<td>269</td>
<td>1,077</td>
</tr>
<tr>
<td>Potato infusion + d</td>
<td>6.9</td>
<td>1,270</td>
<td>1,077</td>
<td>1,077</td>
</tr>
<tr>
<td>Potato infusion + e</td>
<td>6.9</td>
<td>819</td>
<td>669</td>
<td>416</td>
</tr>
<tr>
<td>Beef liver</td>
<td>7.0</td>
<td>513</td>
<td>571</td>
<td>416</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strain</th>
<th>2308</th>
<th>295</th>
<th>2500a</th>
<th>786a</th>
<th>2480b</th>
<th>2401b</th>
<th>1176</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cells, no. × 10⁹</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- European type.
- American type.
- 0.5 per cent dextrose.
- Dextrose, sodium chloride, peptone, meat extract, glycerol.
- Dextrose, sodium chloride, peptone.

Presented in Table 5 show that two of the agar mediums, trypticase soy and tryptose, were inferior to the other three for the production of large numbers of *Br. abortus* and *Brucella suis* cells. By increasing the amount of dextrose in peptone M medium from 0.1 to 0.5 per cent, the yield of bacterial cells of all strains was increased 80-100 per cent. The potato medium minus meat extract and glycerol was less productive than the one containing these constituents.

Each of the agar mediums that was prepared from the different varieties of potatoes and inoculated with the strains of *Brucella* described in Table 5 yielded approximately $12 \times 10^{10}$ of bacterial cells per Petri plate. It is of interest to note that the number of cells of the European-Latin American type of *Brucella melitensis* harvested from the potato mediums was considerable less than the number harvested from any one of the other mediums. The American type of *Br. melitensis*, however, grew as well on the potato mediums as the other species of *Brucella*.

Beef liver agar prepared according to a previously described formula (4) ranked third in its productiveness of *Br. abortus* cells. *Br. abortus* always grew well on liver agar when the inoculum contained a large number of cells, but no growth occurred from inoculums containing 1000 or less cells without the presence of NaHSO₃ or Na₂S₂O₃ (0.05 per cent).

Comparison of the colonial morphology of *Br. abortus* on different agar mediums. Between 80 and 130 cells of one aerobic S-type of *Br. abortus* were seeded on the surfaces of five different agar mediums in Petri plates and the plates incubated at 37°C. for 96 hours. The mediums were examined at the end of 48 and 96 hours to
TABLE 6
Colonial Morphology of Br. abortus (Aerobic) on Different Agar Mediums

<table>
<thead>
<tr>
<th>Medium</th>
<th>pH</th>
<th>Period of Inc Hrs.</th>
<th>Colonial Morphology&lt;sup&gt;d&lt;/sup&gt;</th>
<th>Stability of cells&lt;sup&gt;e&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Diam. (mm.)</td>
<td></td>
</tr>
<tr>
<td>Tryptose</td>
<td>6.9</td>
<td>48</td>
<td>0.2</td>
<td>Cloudy, blue-green, yellow center</td>
</tr>
<tr>
<td></td>
<td></td>
<td>96</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Tryptose</td>
<td>7.2</td>
<td>48</td>
<td>0.7</td>
<td>Blue-green, small yellow center</td>
</tr>
<tr>
<td></td>
<td></td>
<td>96</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>Tryptase soy</td>
<td>7.3</td>
<td>48</td>
<td>0.7</td>
<td>Blue-green, reddish-yellow center</td>
</tr>
<tr>
<td></td>
<td></td>
<td>96</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>Peptone M</td>
<td>6.9</td>
<td>48</td>
<td>0.4</td>
<td>Reddish-yellow, green border</td>
</tr>
<tr>
<td></td>
<td></td>
<td>96</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>Potato infusion +&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.9</td>
<td>48</td>
<td>0.1</td>
<td>Light yellow, opaque</td>
</tr>
<tr>
<td></td>
<td></td>
<td>96</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Potato infusion +&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.9</td>
<td>48</td>
<td>0.2</td>
<td>Light yellow, opaque</td>
</tr>
<tr>
<td></td>
<td></td>
<td>96</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Beef liver</td>
<td>7.0</td>
<td>48</td>
<td>No growth</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef liver +&lt;sup&gt;c&lt;/sup&gt;</td>
<td>7.2</td>
<td>48</td>
<td>0.7</td>
<td>Blue-green, light yellow center</td>
</tr>
<tr>
<td></td>
<td></td>
<td>96</td>
<td>2.3</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Dextrose, sodium chloride, peptone, glycerol, meat extract.
<sup>b</sup> Dextrose, sodium chloride, peptone.
<sup>c</sup> 0.05 per cent NaHSO₄.
<sup>d</sup> ca. 80-130 colonies per agar plate.
<sup>e</sup> Acriflavine spot test.

determine differences in the diameters and natural colors of colonies. Cells of colonies on each medium were also examined by the acriflavine spot for agglutinability.

The results presented in Table 6 furnish information as to the comparative value of the different mediums for the initiation of rapid growth of colonies and for the study of colonial variation (12). Colonies were slower in developing and the colors less typical of the S-type on the potato medium than on the other mediums. The colonies were more like R- or M-types than the S-type. Peptone M medium produced larger colonies than the other mediums, but they were difficult to identify as the S-type; the blue-green color that normally characterizes the S-type was almost absent. Cells from colonies on each medium were stable in acriflavine.
DISCUSSION AND SUMMARY

The results of the experiments presented in this paper emphasize the importance of studying culture mediums and the conditions that are optimum for the growth of small numbers of Brucella in order to improve techniques for their isolation from infective materials such as blood and milk. It has been demonstrated that the liquid mediums and cultural conditions that were optimum for the growth of fastidious strains of Br. abortus without blood, failed to initiate growth in its presence. Fresh blood in liquid medium introduced two factors which retarded and often prevented the growth of living brucella cells. The activity of one, the bactericidal antibody-complement system, was suppressed by the presence of a sufficient number of non-viable brucella cells; that of the other, the glycolytic action of erythrocytes, was controlled and made use of to obtain the CO₂ tension essential for the growth of CO₂-dependent strains of Brucella. The growth of non CO₂-dependent strains was also enhanced by the same procedures. The culture medium should be adjusted to a high pH (8.0-8.4) with Na₂CO₃ and the medium container sealed after the addition of whole blood. The container must be kept sealed during the period of incubation, otherwise the CO₂ produced by the decomposition of carbonate will be lost.

The results of the experiments presented herein and those published previously (5) leave little doubt that trypticase soy broth, from which dibasic phosphate has been omitted, is a superior medium for blood culture purposes. McCullough (13) has previously reported that this medium is a suitable one for the isolation and growth of Brucella.

The failure of Br. abortus type II cells to grow rapidly in tryptose broth or on tryptose agar in the absence of bacterial cells, blood serum, or serum albumin indicates that the medium is either deficient in an essential growth factor or that it contains a bacteriostatic agent. The medium is not totally lacking in elements that support growth of the fastidious strains of Br. abortus. Growth does occur when the inoculum contains large numbers of living bacterial cells.

The methods employed in promoting the growth of Br. abortus type II cells in tryptose medium are in some respects analogous to the one employed by Dubos (14) in promoting the growth of Mycobacterium tuberculosis in a medium containing oleic acid. He found that this fatty acid prevented growth at a concentration of 1 μg./ml. The growth-inhibiting action of the fatty acid was reduced or abolished by the addition of crystalline serum albumin to the culture medium. Preliminary results of studies now in progress in the author's laboratory suggest that certain strains of Brucella are sensitive to a fatty acid. This may well be the factor in tryptose medium that delays growth and which is neutralized by bacterial cells, extracts from bacterial cells, blood serum, or serum albumin.

A comparative study of agar culture mediums for the production of large numbers of brucella cells revealed that two, potato and peptone M, were superior to the other mediums for producing large yields of Br. abortus and Br. suis cells. The potato medium was found inferior to the others for growing the European type of Br. melitensis. The cause of poor growth of strains of this type lies possibly in the rapid decrease in the pH of the medium during initial growth. Decrease in the pH
of potato agar does not occur during the growth of other species of *Brucella* or the American type of *Br. melitensis*.

Potato and peptone M agar were inferior to the other mediums for use in colonial studies. S-type colonies on either potato or peptone M agar were lacking in natural colors that characterize this type on other mediums.

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# BOVINE BRUCELLOSIS: A REVIEW OF THE LITERATURE ON DIAGNOSIS AND CONTROL

W. N. Plastridge, Ph.D.*

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General Information

Early Literature. The earliest recorded evidence of brucellosis in cattle in the United States appeared in “The Cultivator” in 1843. (Evans (1)). At this time many losses from abortion in cattle in New York, Pennsylvania, Delaware and Virginia were reported. Evans suggests that Brucella abortus may have been brought to this country in cattle since abortion rates of 50 to 60 per cent were observed in some parts of Great Britain in 1567. Epidemics of abortion occurring in cattle in the region of the Mississippi River are described in a book written by Jennings in 1864 (Huddleson (2)). However, the nature and common cause of these outbreaks were not known until several research workers in Europe studied the problem.

Frank, in 1876, established the contagious nature of the disease by placing in the vaginas of pregnant animals portions of fetal membrane discharged in an abortion. Twelve years later, Nocard, isolated a micrococcus or short bacillus from exudate from cows which aborted, however, he failed to produce the disease. (Mohler and Traum (3)).

Bang (4), a Danish veterinarian, was more fortunate than Nocard. He not only succeeded in culturing the “abortion bacillus” but was able to produce infection and abortion by instilling cultures into the vaginas of pregnant cows. The work of Bang was soon confirmed in Hungary, Germany, and England.

In the United States, Br. abortus was first isolated from cows which aborted, at the Illinois Experiment Station, by Mac Neal and Kerr (5).

Susceptibility to Infection. As shown by Rettger and White (6), calves up to eight months of age, with few exceptions, are resistant to infection. Resistance in unvaccinated heifers then gradually decreases as they reach sexual maturity. Contrary to popular opinion, and a report by Edgington and Donham (7), unbred unvaccinated heifers are susceptible to infection. Rettger and White (6) found that 28.9 per cent of 38 animals that changed from negative to positive in three herds did so before their first service. More recently, Manthei (8) reported that six of 24 unbred heifers, that accidentally escaped and traversed the area around pens containing infected cattle, became infected. However, it is generally agreed that susceptibility is greatest during pregnancy. According to Huddleson (2) about 70 per cent...
of pregnant cows (not calf vaccinated) abort following initial infection, subsequently some of these cows are sterile but those that conceive have a lower abortion rate.

Nutrition appears to have no effect on resistance to brucellosis. Hart et al. (9) found that the resistance of a group of cattle that were fed a highly nutritious diet plus minerals, cod liver oil, and iodized salt, was no greater than the resistance of a control group that was fed a ration low in protein and mineral content. Gwatkin and MacLeod (10) found that injection of wheat germ oil had no effect on the course of the disease.

*Infection in the Cow.* Infection tends to localize in the pregnant uterus, udder and lymph glands of the affected cow. In the gravid uterus, the placenta is attacked and the resulting inflammatory changes when severe cause premature expulsion of the fetus. If the inflammatory changes are mild, calving may occur at full time. *Br. abortus* has been found in the placenta of blood test positive cows following normal parturition by Cotton (11), Gwatkin (12) and others. The organism usually disappears from the uterus of infected cows within a period of 60 days following parturition, but remains present in the udder and lymph glands (Cotton (11), Schroeder and Cotton (13), Giltner and Bandeen (14)). In some cows the organisms remain present in the uterus for a longer period and interfere with conception, according to Fitch et al. (15). Isolation of *Br. abortus* from cow’s milk was accomplished for the first time by Schroeder and Cotton (16). The organism was found in the milk from apparently healthy cows, as well as from cows that aborted. Udder infections of five years duration were observed. Their observations have been confirmed by many investigators including Gwatkin (12) who found *Br. abortus* in the milk of 18 of 34 blood test positive cows that calved at full time.

*Infection in the Bull.* The possibility of spread of infection by the bull was suggested by Bang (4). Permanent infection in bulls, as indicated by the blood test, was observed by Rettger and White (6). Isolation of *Br. abortus* from the testicles of five of 37 blood test positive bulls was reported by Buck et al. (17). However, Hadley and Lothe (18) and King (19) were unable to infect heifers by natural service to blood test positive bulls. Two of the bulls used in King’s experiment were excreting *Br. abortus* in their semen. Thompson (20) infected five of 15 heifers by breeding them to a bull immediately following the introduction of ground infected placental tissue into the preputial sac.

In general, it appears that natural service in infected herds is not a principal means of spreading infection. However, the addition of bulls from positive herds to negative herds is one way negative herds may be reinfected (Plastridge et al. (21)).

Spread of infection by artificial insemination with semen from infected bulls has been demonstrated by Seit (22) Bendixen and Blom (23) and Manthei et al. (24). Usually infected bulls show no physical evidence of the disease. However, orchitis sometimes results from localization of infection in the testes (Gilman (25)).

*Infection in Animals Other Than Cattle.* Swine and horses are susceptible to infection with *Br. abortus*, and can serve as a source of infection for cattle. Dogs, cats and rats are resistant but can serve as temporary carriers of infection. *Brucella melitensis*, a close relative of *Br. abortus*, occurs in goats in some sections of the United States. (To-date no infection has been found in goats tested in Connecticut).
Brucellosis in swine was first diagnosed in the United States by Traum (26). Many subsequent reports show that the disease is widespread and often causes serious losses from abortion. Brucella organisms commonly found in swine (Brucella suis) differ from those usually found in cattle by being more pathogenic for man and guinea pigs, not requiring an increased CO₂ tension in the surrounding atmosphere for growth on culture mediums, and by susceptibility to certain dyes (Huddleson (2)). Br. suis has been isolated from cow's milk by Hasseltine (27) and others. A review of swine brucellosis has been written by Hutchings (28). (In Connecticut, swine are seldom kept on premises used by cattle, and consequently do not appear to be an important source of infection for cattle. Nevertheless the possibility of transfer of infection from swine to cattle cannot be ignored).

Brucellosis in horses appears to be fairly common, and was first reported in 1924. McNutt and Murray (29) isolated the organism from the aborted fetus of a mare, however, abortion is not a common symptom of equine brucellosis. Fistula of the withers is a common characteristic of the disease in horses, as shown by Rinjard and Hilger (30), Fitch et al. (31) and others. Karlson and Boyd (32) examined five horses that reacted to the agglutination test for brucellosis; and isolated Br. abortus from the feces of two, an abscess of the withers of one, lesions of the sternum of one, and lesions of the ribs of the fifth horse. Evidence that infected horses may be a source of infection in cattle was presented by White and Swett (33) and Fitch and Dodge (34).

Sheep, dogs, and cats possess a high degree of resistance to brucellosis (Boyd (35)). However, dogs may temporarily shed Br. abortus in their urine and feces following the ingestion of infected milk or aborted material, and a few cases of abortion in bitches on farms with infected cattle have been reported by Morse (36). Rats may also serve as carriers of infection following the ingestion of infected material, according to Fitch and Bishop (37).

Economic Importance of Brucellosis. Losses from brucellosis result from a decreased calf crop, lowered milk yield owing to delayed or interrupted pregnancy, and depreciated value of the infected cow. Thompson (38) maintained an infected and a negative herd and calculated the cost of milk produced by both units. The cost was 37 per cent less for the negative unit. Losses from infection in the University of Connecticut herd during the period from 1914 to 1924, before brucellosis was eliminated, were estimated by White et al. (39) at $44.01 per year for each infected cow. Following elimination of infection from the herd, the annual milk yield per cow averaged 1,505 pounds more than when infection was present, and the sale of surplus animals showed a marked increase (White et al. (40)).

Minett and Martin (41) found that the reduction in milk yield due to Br. abortus infection in a Friesan herd averaged 20.7 per cent, in spite of the fact that the infected animals did not abort.

The extent of infection in cattle in the United States is indicated by the records of the United States Bureau of Animal Industry. According to a review by Knapp (42) the national average was 9.83 per cent in 1934, and 6.68 per cent in 1940. When blood testing was started, the incidence was found to vary greatly in different states; for example, 22 per cent in Connecticut and from 3 to 10 per cent in southern states. Mingle (43) reported that for the year ending June 30, 1953, 3.4 per cent of the 7,750,000 blood tests made in the United States were positive. However, many
of the herds concerned had been under test for sometime. Consequently, the percentage reported is undoubtedly lower than the percentage for the cattle population as a whole.

Reduction in the incidence of infection in cattle has been paralleled by a decrease in human brucellosis. Steele et al. (44) observed that the number of human cases reported annually in the United States dropped from a high of almost 8000, in 1947, to less than 3000 in 1952. In Connecticut, the incidence of infection in cattle has been reduced from an estimated average of 22 per cent to less than 5 per cent, primarily by compulsory calf vaccination since 1945 (Plastridge et al. (45)). The decrease in infection in cattle has been accompanied by a decrease in the number of human cases reported annually from a peak of 178 in 1947 to 27 in 1953 (Hart et al. (46)).

TRANSMISSION

The routes of infection are the vagina, mouth, skin and eye. Bang (4) showed that infection can be produced by placing cultures in the vaginas of pregnant cows, and Rettger et al. (47) infected open heifers by swabbing the vulva with cultures. Birch and Gilman (48) demonstrated that infection can be readily induced by feeding infected grain. Cotton and Buck (49) found that living Br. abortus organisms can pass through the unbroken skin, as well as the abraded skin. Cattle were infected experimentally by way of the conjunctiva by Schroeder (50).

The presence of an infected cow in a herd is a constant source of infection to other animals. Sanitation and use of maternity stalls are valuable aids in reducing spread of infection. However, under practical conditions it is impossible to eliminate all chances of transfer of infection within a herd. In infected herds negative animals may become infected by contact with aborted material, licking infected cows, and eating feed contaminated directly by discharges from infected cows or by persons carrying infectious material on their shoes. Dust and flies may also serve as carriers of Br. abortus. The possibility of transmission during milking can not be eliminated, although this has not been investigated.

The viability of Br. abortus in manure, water and soil has been determined. In trials conducted by Cameron (51), Br. abortus survived 120 days in manure, 77 days in water and 66 days in wet soil when the test materials were kept at room temperature. In similar experiments made by Kuzdas and Morse (52) Br. abortus survived 10 days in water and 29 days in manure and soil kept at 25°C. However, in manure and soil stored continuously at freezing or near freezing temperatures Br. abortus survived for periods up to 800 days. These findings suggest that barns and pastures used by infected animals could harbour infection for periods up to six months in the northern states and for a shorter time in the central and southern states.

Probable sources of new infection in Connecticut herds were investigated by Plastridge et al. (21). The addition of recently infected cows (negative at time of purchase) from untested or infected herds was the most common source of reinfection. The addition of bulls from infected herds, contact with animals from neighboring herds through inadequate or broken pasture fences, and association with infected horses or swine were also apparent sources of infection. Circumstantial
evidence indicates that in some instances infection was carried to negative herds by persons coming directly from infected herds.

**DIAGNOSIS**

Little progress was made in the control of brucellosis until a practical method of diagnosis was developed, and until it became recognized that all abortions are not due to brucellosis and that all infected cows do not abort. Serologic tests on blood and milk, allergic tests, and bacteriologic examinations of milk and aborted material have been used in the diagnosis of brucellosis in cattle. Of the several procedures available, the blood serum agglutination test is now generally recognized as the most accurate procedure for use in routine control programs.

**Tube Agglutination Test on Blood Serum.** The test is based on the fact that the blood of man and animals affected with certain infectious diseases, acquires the ability to agglutinate, or precipitate, suspensions of the causative bacterium. This principle was first used in brucellosis by Wright and Semple (53) in the diagnosis of brucellosis in man, and in the diagnosis of brucellosis in cattle by Grinsted (54) a Danish veterinarian. Surface (55) was the first to use the test in the United States and suggested that positive reactions in serum dilutions of 1 to 100 or above, indicate infection. He and others used both the agglutination and complement fixation tests and found close agreement between the two methods. Moore (56) regarded the complement fixation test as impracticable. Mohler and Traum (57) suggested use of the agglutination test alone, because it is less expensive. Both tests were used in the first work in Connecticut (Rettger and White (6)) and the complement fixation test was discontinued in 1930.

In the approved procedure for the tube agglutination test, the antigen in concentrated form (4.5 per cent suspension of cells) is supplied by the United States Agricultural Research Service. The antigen is standardized so that the desired concentration for use in the test is obtained by adding one part of concentrated antigen to 100 parts of phenolized saline solution. The diluter is prepared by dissolving 0.5 per cent of phenol and 0.85 per cent of sodium chloride in distilled water. The density of the diluted antigen corresponds to about 1.5 on the McFarland nephelometer scale. Four dilutions of serum are prepared by placing 0.08, 0.04, 0.02, and 0.01 ml. of serum, respectively, in each of four test tubes (5 in. by 1/2 in. O.D.) and adding 2 ml. of antigen. Tube test readings are made after 40 to 48 hours incubation at 37C. In some states the 1:25 dilution of serum is omitted.

The interpretation of reactions adopted by the 1932 Conference of Official Research Workers in Animal Diseases of North America and later by the Bureau of Animal Industry is as follows:

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<tr>
<th>Serum dilution</th>
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Agglutination: — none, i incomplete, + positive.
The incidence of suspicious reactions, and the results of repeated tests on suspicious and positive animals have been observed. White et al. (58) observed an incidence of suspicious reactions in negative herds of 3.2 per cent and in infected herds of 14 per cent. In infected herds, 31 per cent of the (+i-) reacting animals, and 63 per cent of the (++i-) reacting animals were positive on retest. In a later report, Plastridge et al. (21) found that 17 per cent of the suspicious animals in previously negative herds, and 64 per cent of those in infected herds became positive, and of 206 positive reactors that were retested, 2 per cent were negative, 3 per cent suspicious and 95 per cent positive. Recovery of a small percentage of positive reacting animals has also been observed by others, including Huddleson and Smith (59), Clark (60), and Mitchell and Humphreys (61). A change from a positive reaction to a negative reaction can result from either a light exposure of a naturally resistant animal to infection, or from vaccination with dead or attenuated vaccine. The majority of suspicious reactors (in animals not calf vaccinated) become negative or positive by the time of retest. However, a few give suspicious reactions persistently or intermittently over long periods. Such animals are seldom infected as shown by Birch (62), Fitch et al. (63) and others.

**Rapid or Plate Agglutination Test on Blood Serum.** A plate method for performing the agglutination test was described by Huddleson and Carlson (64) and Huddleson and Abell (65). The original antigen was a dense suspension of heated cells in a solution of 12 per cent sodium chloride, 0.5 per cent phenol, and 0.1 per cent gentian violet, in distilled water. Later, the dye content was changed and glycerin and gelatin were added (Huddleson (2)). The density and gelatin content are adjusted so that the antigen will give results similar to those obtained by the tube test. The plate test is made by placing 0.08, 0.04, 0.02 and 0.01 ml. amounts of serum on ruled squares of a glass plate and mixing one drop of antigen (0.03 ml.) with each amount of serum. The plate is slowly tilted back and forth for two or three minutes, and then placed over an illuminated box. The light is turned off, except during observation, to prevent overheating. The plate is taken up and gently rotated after five minutes and then replaced on the box. The serum-antigen mixtures are observed for a period of five to eight minutes for agglutination, or flocculation of the antigen.

The tube and plate tests have been compared by many investigators, including Damon (66), Graham and Thorp (67), Gwatkin (68), and Donham and Fitch (69). In general, fairly close agreement (90 to 95 per cent) occurs when tests are applied to negative and positive reacting samples, disagreement is most likely to occur when suspicious samples are examined, and the proportion of suspicious reactions tends to be greater when the plate test is used. Factors that control agglutination such as concentration of the serum-antigen mixtures, temperature, and the time interval between mixing the antigen and serum and reading the results, are not as well controlled in the plate test as in the tube test. Consequently, the plate test is generally considered less reliable than the tube test. However, the plate test can be used to advantage in areas where facilities for transporting samples to a central laboratory are poor, or lacking.

Since 1939, the United States Bureau of Animal Industry has supplied official testing agencies with both plate test antigen and tube test antigen, along with directions for their use. This has improved the accuracy of both tests.
Interval Between Infection and a Positive Blood Serum Reaction. In all infectious diseases a period of time elapses between exposure to infection and the development of physical symptoms and positive serologic reactions. In bovine brucellosis this interval varies from two weeks to seven months depending upon three factors, (1) virulence and number of invading brucella organisms, (2) resistance of the animal, and (3) the stage of the breeding cycle at time of exposure.

Birch and Gilman (48) found that in a group of nine pregnant heifers exposed by feeding bran and cornmeal infected with *Br. abortus*, positive blood titers were obtained four to eight weeks after exposure, and six of the heifers aborted during a period of from five to 18 weeks following exposure.

McEwen et al. (70) inoculated five groups of pregnant heifers by way of the conjunctiva with different numbers of *Br. abortus* cells. The ten heifers that received a large dose \((1,460 \times 10^6)\) developed a positive blood serum titer in 14 to 28 days. As the number of organisms was decreased, the length of time required for the development of a positive reaction tended to increase, although a wide difference was obtained between animals. Of the ten heifers that received a small dose \((1,460,000\) organisms) five developed positive blood serum titers; on the 65th, 80th, 106th, 123rd and 156th days, respectively. Five remained negative.

Experiments conducted by Thomsen (71) showed that the younger the fetus at the time of infection, the longer is the incubation period. Individuals in a group of nineteen heifers were exposed, orally and by way of the conjunctiva, at intervals ranging from 10 days to seven months after service. Sixteen of the 19 heifers aborted. The average interval required for the development of a positive blood agglutination titer decreased from 207 days for the two heifers exposed 21 days after service to 53 days for the single heifer exposed seven months after service.

These findings show that a single negative blood test on an animal from an infected herd is of limited value.

Factors Influencing the Blood Serum Agglutination Test. In the early work on brucellosis, each laboratory made the antigen used. As a result, discrepancies occurred in the test; owing to use of cultures which either agglutinated poorly with positive serum or agglutinated with negative serum, and to differences in technic of making the test (Huddleson (2)). These faults were largely overcome when the United States Bureau of Animal Industry began supplying antigen to state laboratories in 1939, along with detailed instructions for its use.

The presence of hemoglobin in the serum interferes with the tube agglutination test. Hemolysis occurs when blood samples are frozen, exposed to summer temperatures for three or more days during transit, or when contaminated with water or disinfectant when drawn.

The possibility of reactions to the brucellosis test due to infection with *Pasteurella multocida* (the hemorrhagic septiciemia organism) has been investigated. Mallman (72) found that anti-*Pasteurella* serum prepared in rabbits agglutinated *Br. abortus* antigen, and Dachena (73) reported that blood serum from cattle suffering from hemorrhagic septiciema contained *Br. abortus* agglutinins. Starr and Snider (74) found that one of two calves injected with live *Pasteurella* cells gave a titer of 1:50 with *Brucella* antigen. Kitselman (75) and Starr and Snider (74) found no *Brucella* agglutinins in cattle following injections with hemorrhagic septiciema bacterin, and
Priestly (76) concluded that there is no cross-agglutination between Pasteurella and Brucella. Morse et al. (77) reported that Vibrio fetus and Brucella are antigenically related, and observed that antiserums prepared in rabbits against seven V. fetus strains gave traces of agglutination with antigens of one or more strains of Brucella in the 1:10 serum dilutions and occasionally at the 1:40 level. At the Storrs Agricultural Experiment Station (unpublished data) a group of 10 heifers (not calf vaccinated) were artificially infected with V. fetus and retested at frequent intervals over a period of two years. Of a total of 832 blood samples from these animals, one gave a suspicious reaction (complete agglutination with Br. abortus antigen in the 1:25 serum dilution and incomplete in the 1:50 dilution). Seventy-four samples gave incomplete agglutination in the 1:25 dilution only. It appears that suspicious reactions to the Br. abortus agglutination test in cattle seldom result from V. fetus infection.

Advanced gestation does not appear to affect the agglutination test, as indicated by retests on positive reactors (Plastridge et al. (21)). However, in infected herds it is not unusual for an animal to react negatively before calving and positively after calving for the reason that she became infected during the late stages of gestation.

Differentiation of specific and nonspecific suspicious reactions by heat treatment of serum was reported by Hess (78). Double strength dilutions of the serum in saline were heated for 10 minutes in a 70°C. water bath. Double strength antigen was then added and the tubes incubated in the usual way.

To-date no form of chemotherapy has been found effective in causing positive reactors to react negatively.

Agglutination Test on Milk Whey. Brucella agglutinins were first found in the milk of infected cows by McFadyean and Stockman (79), however, owing to the opacity of the fluid, tests on milk were regarded as of little value. This difficulty was later overcome by coagulating the milk with rennet and applying the test to the whey. Coolige (80) considered agglutination tests on milk of value in detecting uterine infection. Smith et al. (81) observed a high titer of the milk when Br. abortus was present and concluded that the uterine tissue participates in agglutinin production. Titers of 1:80 on milk from individual quarters were usually associated with uterine infection, although Br. abortus was occasionally isolated from milk with a lower titer, in studies by Gilman (82).

The procedure for examining milk for Brucella agglutinins, as recommended in standards for the production of certified milk, is described in the book "Bovine Mastitis" by Little and Plastridge (83). Whey dilutions of 1:5, 1:10, 1:20 and 1:40 are used. For herd milk, a positive reaction in any dilution is considered indicative of herd infection, and for individual cows agglutination in the 1:20 dilution is regarded as positive.

The findings of Graham and Thorp (84), Huddleson (2), and others, that Br. abortus may be present in milk with negative or low titers, and that the milk of blood test positive cows may be negative, has led to the general opinion that tests on milk are of limited value.

Ring Test. The "A.B.R." (Abortus Bang Ring) test is much more sensitive in detecting Br. abortus agglutinins in milk than the whey agglutination test and is easily made. The method, in brief, consists of mixing 2 drops of antigen (a deeply
stained suspension of *Br. abortus* cells) to 2 ml. of milk, allowing the mixture to stand at room temperature for 75 to 90 minutes, and then observing the color. A uniform color in the column of milk is interpreted as negative, and a blue cream layer (ring) as positive. The color of the ring may vary from light blue (+) to a very dark blue with the skim milk portion nearly white (+++). The test was developed for use on pooled herd milk for the purpose of detecting infected herds. Positive ring tests have been obtained when the pooled milk represented milk from one infected cow and from five to 15 noninfected cows (Roepke (85)).

The ring test was first described by Fleischhauer (86). As reported by Roepke (85), the test has been used in Sweden and Denmark for locating infected herds, and reducing the number of blood serum tests needed in accrediting herds.

The technic of preparing antigen and making the test, and the results of 30,811 herd tests made in 25 counties in Minnesota have been reported by Roepke (85), and Roepke et al. (87). Roepke summarized his results in terms of approximate ratios as follows:

1. The ring test was positive on 2 out of 3 herds classed as infected on the basis of the blood serum agglutination test results.
2. Of the failures of the ring test on infected herds 2 out of 3 of the failures were due to the fact that the only infected animal or animals in the herds were not in production, i.e., they were heifers and dry cows.
3. The ring test was positive on 9 out of 10 herds in which one or more infected animals were in production.
4. In 2 out of 3 herds positive to the ring test there was agreement with blood test results.

The Minnesota survey indicated that one county-wide test may locate 55 to 60 per cent of the infected herds, and two tests six months apart from 70 to 80 per cent of the infected herds.

In discussing the ring test Roepke comments that the test by itself cannot be considered a highly reliable herd diagnostic test for brucellosis and that the test should not be used by individuals who are inexperienced with serologic tests or who do not understand the limitations of the test. He points out that the test is even less accurate on an individual animal basis than on mixed milk from a herd. He suggests that the ring test can probably best be used as an adjunct to the blood test in an official type of control program, especially in areas where the percentage of infected herds is low (1 to 5%). In such areas periodic ring tests would be a means of directing blood testing work to those herds most likely to be infected.

Two modifications of the *Br. abortus* ring test have been described. The one described by King (88) consisted of drawing ring test antigen and milk into a capillary tube (0.8 by 90 mm.), and observing the tube for “ring” formation at the top of the column. On 428 individual cow samples tested by King agreement with the blood test was 92.7 per cent. On herd milk samples, Morse et al. (89), found the ring test “slightly more accurate than the capillary tube test”. A milk plate test was described by Blake et al. (90). He reported that the milk plate test was positive on milk from 18 blood test positive cows that shed *Br. abortus* in their milk, and negative for 19 cows that were negative to blood tests and cultural tests. However,
tests on 22 blood-test-positive-milk-culture-negative cows varied from negative to positive.

Several factors may affect the results of the ring test. Inclusion of colostrum, milk from cows in late lactation and the secretion from mastitis udders in the herd milk may account for positive reactions, especially weak reactions, given by milk from blood test negative herds (Bruhn (91) and Holm et al. (92)). The data obtained by Roepke (85) suggest that calf or adult vaccination with Br. abortus strain 19 vaccine may interfere with the reliability of the ring test, but to what extent has not been determined.

Agglutination Test on Bull Semen. The possibility of testing the plasma of bull semen for Brucella agglutinins is suggested by the work of Bendixen and Blom (23). Christensen (93) found that in 24 of 28 bulls with Brucella infection of the genital organs the agglutinin titer of the semen plasma was higher than that of the blood serum.

Agglutination Test on Uterine Fluid. Jepson and Vindekilde (94) observed local formation of agglutinins in the genital organs of Brucella infected cows. Several cows were observed in which fluid from the uterine mucosa gave a higher agglutinin titer than their blood serum. A technic for collecting fluid for test from live cows by the use of a tampon was developed by Szabo (95) and is described by Plastridge et al. (96). Jepson and Vindekilde used the tampon method in an infected herd and found 11 cows in which genital tract fluid was positive and the blood serum negative. Further investigation is needed to determine possible application of the test in brucellosis control.

Allergic Tests. Attempts have been made to diagnose brucellosis in cows by injecting Brucella cells, or products of Brucella cells, and observing the animals for evidence of hypersensitivity. The several tests devised are generally regarded as inferior to the blood serum agglutination test.

Mc Fadyean and Stockman (79) injected cattle intravenously with an "abortin", a filtrate of Br. abortus cultures, and observed the animals for a rise in temperature. Subsequent work by Meyer and Hardenbergh (97), Mohler and Traum (57), and others, showed that the test was unreliable.

Intradermal injection of heat killed suspensions of Br. abortus cells and extracts of cells have been tried. Edgington and Broerman (98) reviewed the work of others on intradermal tests with heat killed cells, and presented results to show that more animals reacted positively to the intradermal test than to the blood serum agglutination test, and that some infected animals were negative to the intradermal test. Sonic filtrates of Br. abortus cells were tried by Live et al. (99) and Live and Stubbs (100). The filtrates used in intracutaneous tests gave unreliable results. More recently, Ottosen and Plum (101) used a precipitated extract of Br. abortus in intradermal tests and expressed the opinion that the test may be useful in testing herds with recent outbreaks of infection.

An ophthalmic test was described by Van der Hoeden (102) who regarded the method as effective in detecting Br. abortus infection in the cow. However, Fitch and Donham (103), and others did not find the test sufficiently reliable to justify its general use.
Bacteriologic Methods. In routine work, use of bacteriologic technics is limited largely to the examination of aborted fetuses for the purpose of determining the presence or absence of pathogenic microorganisms, especially Br. abortus, V. fetus, Trichomonas fetus, and pyogenic bacteria. As a rule uterine exudate (unless collected from the uterus with a sterile tube) and placental tissue are grossly contaminated with saprophytic bacteria that prevent satisfactory cultural tests. However, a useful staining technic has been devised for detecting Br. abortus in placental tissue. Tests on milk are fairly easily carried out; however, four samples from each cow are needed, Br. abortus is not always present in the milk of infected cows, and the cost of tests on milk is too high for their routine use. Procedures for examining various tissues and body fluids are described by Huddleson (2). Bacteriologic procedures found useful in routine work at the Storrs Agricultural Experiment Station will be described briefly.

Fetuses. These should be brought to the laboratory immediately, or frozen and shipped in insulated containers. An alternative method for large fetuses: Remove about 20 ml. of stomach fluid aseptically, place the fluid in a sterile container, freeze and ship in an insulated container. Freezing does not kill pathogenic bacteria but does destroy trichomonads if present.

Liquid mounts of stomach and amniotic fluid are examined under a microscope for trichomonads. Films of these fluids are stained with diluted aqueous carbol-fuchsin and examined for vibrios. The “phase” microscope has distinct advantages in examining liquid mounts for vibrios and trichomonads.

Stomach fluid, amniotic fluid and lung tissue are cultured in “thiol” medium (Difco) and on ox blood agar plates. The inoculated mediums are incubated at 37°C, in sealed jars in which about 5 per cent of the air is replaced with CO₂, and examined after three and five days. The thiol medium is examined for growth of V. fetus. The blood agar plates are examined for colonies resembling Br. abortus, V. fetus, hemolytic staphylococci and C. pyogenes. Films are made of cells from colonies resembling those of Br. abortus and V. fetus and stained with dilute carbol-fuchsin. The morphology of these two organisms is such that they can usually be tentatively identified by microscopic examination. Subcultures from colonies of suspected pathogens in suitable mediums are identified. Suspected Br. abortus colonies are cultured on nutrient agar and the subsequent growth used to prepare antigen for agglutination tests against stock anti-Br. abortus serum. The different types, or species, of Brucella may be differentiated by the dye plate method of Huddleson (104).

Placental Tissue. A portion of cotyledon, preferably one showing inflammation or necrosis, is removed, washed, dipped for two seconds in boiling water, and ground in a sterile mortar with sterile sand and a small amount of sterile nutrient broth or saline. The resulting suspension is cultured on blood agar. In addition, a film is prepared and stained by the method developed by Koster and described by Christoffersen and Ottosen (105) as follows:

1. The film is dried and fixed over a flame.
2. Preliminary staining with alkalinized safranin solution for 1 minute (1.5 ml. of a molar solution of KOH plus 5 drops of a 3 per cent aqueous safranin solution).
3. Thorough washing in water.
4. Differentiation with 0.05 per cent \( \text{H}_2\text{SO}_4 \) solution for 15 seconds.
5. Thorough washing.
6. After-staining with a 3 per cent aqueous methylene blue solution for 15 seconds.

By this method *Br. abortus* cells appear red against a blue background. Most of the other bacteria present in the film are stained blue.

**Attempts to Differentiate Vaccinal from Natural Infection Titers.** Some calf vaccinated heifers give suspicious (++i−−− and ++i−−) and a few give positive reactions, especially weak positive reactions (+++i), when 24 to 30 months of age. These reactions may result from vaccination after the recommended eight months age limit, and from exposure to infection when the heifers are raised in *Brucella* infected herds. However, a small percentage of properly vaccinated calves in Brucella negative herds retain a suspicious or positive blood titer after they become two years of age. Some of these animals undoubtedly have a subnormal natural resistance to brucellosis and as a result are slow in eliminating the strain 19 organisms (vaccine) and returning to a negative status. A few continue to give suspicious reactions continuously or intermittently over a period of several years.

Several methods for differentiating vaccinal from infection titers have been tried. While these methods show promise, in general, they do not appear to be sufficiently accurate for use in routine work. Further research on the significance of suspicious reactions in properly calf vaccinated animals in both brucellosis-free and infected herds may show that titers now classed as suspicious should be classed as negative. A review of the literature on differentiation of vaccinal and infection blood serum titers for brucellosis has been written by Manthei (106).

**Tests on Milk.** Traum and Maderious (107) observed the whey titers of quarter milk samples from 342 cows vaccinated with strain 19. They found that 79.4 per cent of those with whey titers of 1:25 or higher had udder infection, as compared with 1.7 per cent of cattle with whey titers of less than 1:25. Similar findings were reported by Blake and Manthei (108) on 380 composite milk samples from 44 cows. Whey titers of 1:25 or higher were given by 94.6 per cent of the samples from 18 infected cows with blood serum titers of 1:100 or higher; and whey titers of less than 1:25 were obtained in 89 per cent of a group of 26 "noninfected" cows of which 65 per cent gave blood serum titers of 1:100 or higher.

Drimmelon (109) regarded a ring test titer of less than 1:4 on individual cow’s milk as indicating absence of infection. A positive ring test reaction in the 1:5 dilution of milk was observed in 19.6 per cent of suspect and reactor vaccinated cattle and in 69.2 per cent of suspect and reactor nonvaccinated cattle, by Holm et al. (92). Blake and Manthei (108) reported a similar ring test titer in 35.5 per cent of “noninfected” vaccinated animals and 97.4 per cent of infected animals.

These results indicate that tests on milk are not adequate for establishing the presence or absence of infection in blood serum suspect and reactor vaccinated cattle.

**Anamnestic Reaction.** The effect of injecting live and dead *Br. abortus* strain 19 cells on the agglutinin titer has been suggested as a means of differentiating vaccinal from infection blood serum titers. In general, a rise in titer occurs in noninfected animals, and no change in titer in infected animals.
The agglutinin response following intramuscular injection of 5 ml. of *Br. abortus* strain 19 vaccine in cattle with suspicious and positive blood serum titers was observed by several workers. No rise in titer following the injection was regarded as indicative of infection and a rise of one dilution or more in titer as indicative of freedom from infection. No rise in titer was reported in 11 infected animals by Dick *et al.* (110), and in 10 of 12 infected animals observed by Barner *et al.* (111). On the other hand, King *et al.* (112) and Manthei (106) identified only 40.0 and 31.4 per cent, respectively, of infected cattle by this method. On the basis of these findings and the production of increased blood serum titers in noninfected cows, this method appears to be of limited value.

Injection of dead strain 19 vaccine cells was tried by Barner *et al.* (111). Nine known infected animals showed no rise in titer, and 12 blood test negative and 18 blood test suspicious cows all showed a rise in titer (2 to 8x) when retested 7, 15 and 22 days after injection. The duration of the induced titers in negative animals was not recorded.

Comment. Consideration of the advantages, limitations, and cost of the methods discussed shows that the tube blood serum agglutination test is the method of choice for the routine diagnosis of brucellosis in cattle. In applying the test the following facts must be recognized.

1. The test is specific for infection or vaccination with members of the genus *Brucella*. Cows that abort, or require repeated services, due to other causes react negatively to the test, unless adult vaccinated.

2. As with all serologic tests, negative reactions are obtained during the incubation period of the disease. A period of from two weeks to three months is usually required for the development of a positive blood serum agglutination reaction following natural exposure to infection with *Br. abortus*.

3. While abortion is a common symptom of brucellosis, especially when infection occurs during pregnancy, over half of the cows infected with *Br. abortus* do not abort.

The ring test on herd milk samples is helpful in locating infected herds, and may be used as an adjunct to the blood test program in areas where the percentage of infected herds is low (1 to 5%). The wide range of reactions obtained, presence of cows out of production in a herd, and the increasing use of tank coolers and tank pick-up trucks tend to limit the use of the test.

No satisfactory practical method has been devised for differentiating vaccinal and infection blood serum reactions. The need for such a test is greatly decreased when calves are vaccinated within the recommended age limits of six and eight months. Subsequent research may show that in applying the blood serum agglutination test to properly calf vaccinated animals, reactions now classed as suspicious may be interpreted as negative.

**CONTROL BASED ON PERIODIC BLOOD TESTS AND SEGREGATION AND DISPOSAL OF REACTORS**

The discovery that the blood serum agglutination test could be used to diagnose brucellosis in cattle suggested the possibility of a control program based on use of the test. Results obtained with the test, and the finding that calves born to positive
dams become nonreactors and can be used as additions to the negative unit, led Rettger and White (6) to suggest the following control measures; (1) periodic tests on adult cattle, (2) segregation and gradual disposal of positive reactors, (3) use of a nonreacting bull, (4) caution in the purchase of new animals, and (5) burning or burial of aborted fetuses and afterbirths.

Barnes (113), after finding that vaccination of adult cattle failed to control abortion in herds under his observation, recommended a test and segregation program, and certification of herds with no positive reactors over a period of one year.

Fitch et al. (114) obtained unfavorable results with adult vaccination with dead and live vaccines. Their experience with the University of Minnesota herd suggested that it is feasible for a breeder to maintain a clean and an infected herd in separate barns on the same premises.

Newsom and Cross (115) refer to the research of Mc Fadyean in England who reported, in 1921, the eradication of infection from three of seven herds by blood testing and segregation. Newsom and Cross describe their own experiences in the Colorado Agricultural College herds. Tests were made at intervals of from 60 to 120 days, and the positive reactors were removed to separate barns and eventually eliminated. It took five tests and 10½ months time to eliminate the disease from the beef herd, and eight tests and a period of 18½ months to free the dairy herd from positive reactors. They concluded that Bang's abortion disease can be eliminated and herds maintained clean by blood testing and segregation.

Rettger et al. (116) found in testing 75 herds that a testing and segregation program was effective in eradicating infection from herds in which infection tended to be stationary, but was not as effective in herds with rapidly spreading infection. At the time of this report, infection had been eradicated from 20 herds. Detailed results in four herds which were freed from infection over periods of from two to three years were given. In two of the herds positive and negative reactors were segregated in the same barn and the positive reactors gradually replaced with heifers raised apart from the main herd. In the third herd the positive reactors were replaced by purchased negative unbred heifers. In the fourth herd of 54 adult cows, the 15 positive reactors were sold at once. Subsequently one additional positive animal was removed.

In New York, Birch et al. (117) used three plans for handling Bang's disease; (1) sale of reactors, (2) complete segregation, and (3) partial segregation. Results were reported for 44 herds. In 33 badly infected herds, infection was eliminated from 12 and satisfactorily reduced in 18. Seven herds with few reactors were freed from infection. Four herds were negative on initial test.

Following these early reports control programs based on the blood test were set up in most states. For the dual purpose of reducing both the incidence of positive reactors and the number of cattle, cooperative state-federal programs were started in 1934. Under these programs herds were tested at state and federal expense, positive reactors were slaughtered and an indemnity paid for condemned animals. Unfortunately the testing program progressed more rapidly than the educational program. As a result disappointing results were obtained in many herds owing to the addition of purchased replacements from untested herds without quarantine and retest, too long intervals between tests, and lack of adequate sanitation. Never-
theless, many herds were freed from infection by retesting at 30 to 45 day intervals, adopting sound sanitary practices, and using care in adding purchased replacements.

The greatest progress was made under the test and slaughter program in those states in which both the incidence of infection and traffic in cattle were low. Three states, North Carolina, New Hampshire and Maine have become modified certified brucellosis-free areas (Kuttler (118)).

The least progress has been made under the test and slaughter program in states like Connecticut with a high initial incidence of infection, 20 to 25 per cent, (Plastridge et al. (21)), and in which a large number of replacements are imported. In such states proper calf vaccination may be used to reduce the incidence of infection in cattle raised within the state to 5 per cent or less (Plastridge et al. (45)). The increased resistance of the calf vaccinated herds makes practical the final eradication of brucellosis by the use of periodic tests and gradual replacement of positive reactors, without the payment of indemnity.

ADULT VACCINATION IN THE CONTROL OF BRUCELLOSIS

In all infectious diseases, attempts to find a vaccination procedure which will increase the resistance of susceptible persons or animals naturally follow isolation of the causative agent. Following isolation of the bacterium now known as *Br. abortus*, vaccines prepared from live virulent cultures were used in attempts to induce resistance to infection in cattle. Later, bacterin (killed vaccine), cell fractions, non-virulent cultures, nonagglutinogenic cultures, and weakly virulent cultures were used. At present, the only type of *Br. abortus* vaccine produced under supervision of the United States Agricultural Research Service is made from a weakly virulent culture designated as strain 19. While its use on mature cattle has been partially successful in preventing abortion from brucellosis, it is best suited for the vaccination of calves between the ages of six and eight months. The present trend is toward the vaccination of calves only.

The literature on vaccination is too extensive to review completely here. Representative reports will be mentioned briefly.

*Bacterin and Cell Extracts.* Killed cells of *Br. abortus* (bacterin) were first tried by Bang (119), however, the results were not encouraging.

The claim that repeated intravenous injections of *Br. abortus* bacterin would render blood test positive cows negative was found invalid by James and Graham (120).

Bacterins prepared by killing cultures of *Br. abortus* with formaldehyde, mercuriochrome, thionin and pyronin were found to be without prophylactic or therapeutic value by Gwatkin and Panisset (121).

*Br. abortus* cells killed with chinosol, methylene blue, iodine and heat were found to be useless as immunizing agents by Zeller and Stockmeyer (122).

Mc Diarmid (123) tried intramuscular injections of formalin killed *Br. abortus* cells suspended in lanolin and liquid paraffin. He concluded that while resistance might be increased by repeated large doses of the lanolin vaccine, strain 19 vaccine was more effective.

More recently Schlingman and Manning (124) reported that subcutaneous injection of *Br. abortus* cells that were inactivated by ultraviolet light irradiation and
precipitated by 4 per cent potassium alum, seemed to increase resistance to subsequent natural exposure in one small herd. Two of four cows given one 5 ml. dose and one of four cows given two 5 ml. doses, became infected when challenged 27 months after treatment. In comparison, two of the five control cows became infected after challenge.

Extracts of cells have been tried experimentally. Trichloracetic acid extract of *Br. abortus* failed to protect guinea pigs in tests made by Priestly (125). A watersoluble agent prepared by Huddleson (126) from suspensions of live cells of *Br. abortus* and *Br. suis* by crushing the cells in a Booth and Green bacterial crushing mill was found to protect a significant percentage of guinea pigs against infection, however, it failed to protect susceptible cows. Live et al. (127) produced an active immunity in guinea pigs by subcutaneous injections of sonic extracts. A fraction prepared from a suspension of cells digested by trypsin was found to produce a "slightly increased" resistance in a group of eight heifers by Paterson and Pirie (128). Virulent Culture Vaccine. Bang (119) reported that the injection of live virulent *Br. abortus* cells subcutaneously into experimental nonpregnant cattle gave some protection against abortion. Field trials by Stockman (129) and Mc Fadyean and Stockman (130) appeared to confirm the findings of Bang.

In 1919, the United States Bureau of Animal Industry permitted the manufacture and distribution of live *Br. abortus* vaccine (Traum (131)). Vaccination on a large scale was carried on in the United States and other countries during 1919 to 1932. During this period research showed that vaccination with live virulent cultures was not only of questionable value in reducing abortion but was actually spreading the disease. As a result of these findings, and the discovery that *Br. abortus* was pathogenic for man, the Bureau of Animal Industry, in 1932, restricted the production of vaccine to strain 19 (Traum (131)).

One of the first reports in the United States on adult vaccination with virulent cultures was made by Hadley (132). He observed an abortion rate of 22.1 per cent in 136 vaccinated heifers, as compared with 33.3 per cent in 26 heifers left as controls. Of a total of 474 vaccinated cows and heifers 20.46 per cent were sterile or aborted, and of 101 control animals 29.11 per cent were sterile or aborted. In observations made by Schroeder (50) on a large purebred herd, the abortion rate was 12.18 per cent for the vaccinates and 16.51 per cent for the controls, and udder infection following vaccination was found in some cows.

A critical review of vaccination with live virulent *Br. abortus* cells was published by Williams (133). He pointed out that the favorable results reported by Stockman, and other European investigators, were based on inadequately controlled experiments stating that "A common defect in these data is that the herds used are almost wholly those which have just passed through an abortion storm and would as a rule abort far less the following year. They are largely made up of grade cows from which aborters are commonly sold and new cattle—perhaps also aborters—are added by purchase, and not infrequently, as in Bland's data, the bought—in cows already destined to abort, are used as controls and of course abort at a high rate leading to false conclusions."
Subsequent research confirmed Williams' view to the extent that vaccination with virulent cultures seldom reduces the abortion below 15 per cent.

Smith and Little (134) reported an abortion rate of 16.7 per cent in 53 vaccinates and 25.1 per cent in 134 controls during the first pregnancy following vaccination. Buck and Creech (135) vaccinated 772 open cows and heifers within three months of breeding age, and observed that 13.1 per cent of those that conceived aborted, whereas, 17.6 per cent of the 369 controls aborted. They observed that the vaccination of infected cows was illogical and valueless, and that the results obtained from vaccinating heifers were better than those obtained from vaccinating open cows. In observations on animals in several infected herds, Barnes (113) reported an abortion rate of 23.2 per cent in 82 animals that were negative to the blood test at the time of vaccination and 17.2 per cent in 44 blood test negative animals that were left as controls.

Lubbehusen et al. (136) reported an abortion rate of 19 per cent in 37 vaccinated cows and 28.7 per cent in 47 controls, and states that "In our judgement the only way with our present knowledge to successfully control the disease resulting from infection with Bact. abortus is on the basis of the clean herd as determined by the serum tests".

Hart and Traum (137) demonstrated that "in a certain percentage of lactating animals injected with Bacterium abortum under the skin of the neck, the organisms so injected, or their progeny, will gain access to the udder and be eliminated with the milk. Vaccinated animals may, therefore, become spreaders of the infectious agent. . . ."

Torrey and Hallman (138) examined vaccines from nine manufacturers and found that three contained no viable cells, and that the cells from the viable vaccines varied in virulence from "highly attenuated" to highly virulent.

On the basis of the accumulated evidence on vaccination, the Committee on Abortion of the American Veterinary Medical Association at the 1929 meeting stated that "... the use of vaccines made from living Bacterium abortus organisms which are virulent or which may become virulent is a dangerous procedure. This is stated not only because of its relation to the control of the infection in cattle and other species of live stock, but because of the possibility of the transmission of the infection to human beings".

Nonvirulent Culture Vaccine. Owing to the failure of virulent Br. abortus vaccine to adequately reduce the abortion rate, and to the spread of infection by use of such vaccine, Huddleson, in 1921, started experiments with a vaccine made from a non-virulent culture. Preliminary tests indicated that vaccine made from this culture protected guinea pigs when exposed by feeding virulent cultures, that the culture was not virulent for cattle, and that some degree of immunity followed its use on cattle (Huddleson (139)).

Huddleson (140) reported an abortion rate of 4 per cent in 175 cattle that were negative to the blood test at the time of vaccination, and an abortion rate of 24 per cent of 152 blood test positive animals that were not vaccinated. Use of the vaccine produced serum agglutinin titers of from 1:1000 to 1:4000 in about 15 days. In the absence of exposure to infection the titers usually dropped to 1:50 or lower, in 12 weeks.
In a later report, Huddleson (141) summarized the results obtained over a seven year period. In herds which contained positive animals (1930–1934) the percentage of animals that became infected was 9.5 per cent for 2672 negative vaccinates and 13 per cent for the 1148 negative controls. The results obtained for 1935–36 showed 1.1 per cent infection in the vaccinates and 6.5 per cent in the controls. While the results indicate that the vaccine gave some protection, at least 10 per cent of the animals injected with the vaccine did not develop sufficient immunity to last for a period of one year.

A vaccine made from a nonvirulent strain of *Br. abortus* was tried by Cotton (142). The vaccine gave only slight protection when given to cows and heifers three to five months before service. Use of the vaccine on pregnant cattle was reported by Cotton et al. (143). Of 10 vaccinated cows and heifers, four resisted infection, whereas, eight of the nine controls became infected.

In general, vaccines made from nonvirulent agglutinogenic cultures seem to have little place in present brucellosis control programs.

**English Strain 45 (20) Vaccine.** During the period from 1936 to 1946, McEwen and associates reported results obtained with their strain 45. The original strain 45 was isolated from a cow prior to 1922, and when examined in 1936 (McEwen and Roberts (144)) was found to be agglutinable, of low virulence for guinea pigs, and capable of producing a high degree of resistance in guinea pigs. McEwen (145) reported that subcutaneous inoculation of noninfected pregnant and nonpregnant cattle did not cause infection of the uterus, and that use of vaccine made from strain 45 in several commercial dairy herds reduced the abortion rate. Following repeated passages of strain 45 through guinea pigs, a rough substrain, later designated as strain 45 (20), was obtained (McEwen (146)).

Results obtained by vaccination of cattle with strain 45 (20) were described by McEwen (147). Vaccination of six heifers before pregnancy protected them against subsequent exposure, did not cause infection, and failed to stimulate the production of agglutinins. He suggested that vaccination with this strain may be practiced in herds that are free from infection in order to increase resistance, and that the chief use of strain 45 (20) vaccine should be in herds where control by isolation of infected animals is impractical. On the basis of results obtained by intravenous inoculation of one cow and two heifers of breeding age, McEwen (148) concluded that strain 45 (20) was incapable of causing either infection or agglutinin production in nonpregnant cattle.

Less favorable results with strain 45 (20) vaccine reported by Edwards et al. (149). In a group of 10 heifers vaccinated before pregnancy and exposed during pregnancy to infection with 150 million virulent organisms, eight calved normally but six were found to be infected following parturition. All of the nine controls became infected, seven aborted and two calved prematurely. In a second experiment eight vaccinated heifers were exposed to 15 million virulent organisms. One aborted from a “nonspecific” cause, seven calved normally and one became infected. In the control group of nine animals, three aborted and six became infected. While the vaccine increased the resistance of the vaccinated heifers, evidence was presented that the strain became virulent when inoculated into nonpregnant lactating cows.
Of nine such animals that were vaccinated before service, *Br. abortus* was isolated at subsequent parturition from the fetal membranes or colostrum of five.

In reply, McEwen (150, 151) presented further data to refute the suggestion that vaccine prepared from strain 45 (20) on inoculation into nonpregnant cows commonly mutates and becomes virulent. Additional results were presented to show the value of vaccinating nonreacting cattle in an infected environment, and that it is possible to blood test and gradually remove positive animals along with vaccination.

Edwards *et al.* (152) compared the immunizing value of United States Bureau of Animal Industry strain 19 with that of strain 45 (20), and found that the immunity produced by strain 19 vaccine appeared to be superior to that produced by strain 45 (20) vaccine. The results obtained on strain 19 vaccinates are summarized in their Table V and show that: Of 18 heifers vaccinated with strain 19, and subsequently bred and exposed to infection 17 produced live calves and three developed infection; and of 19 controls, four produced live calves and all became infected. Their results with strain 45 (20) vaccine were recorded previously (Edwards *et al.*, 1945). In the group of 18 heifers vaccinated with strain 45 (20), 15 calved normally, one calved prematurely, two aborted (one from an unknown cause) and seven became infected.

The stability of the avirulent characters of the two strains following repeated passages through pregnant cows was studied by Taylor and McDiarmid (153). After seven passages, strain 19 appeared to remain unchanged in respect to ability to grow in air and to its accepted low virulence for guinea pigs. On the other hand, by the seventh passage strain 45 (20) had become a highly virulent \( \text{CO}_2 \) sensitive strain. Its “R” character and inability to produce agglutinins was lost between the second and third passage.

“M” Vaccine. A mucoid phase of *Br. abortus* which was inagglutinable by antiseraums against ordinary cultures and which produced low agglutinin titers only after repeated injections into rabbits was described by Plastridge and McAlpine (154). Huddleson (155, 156) found that mucoid phase cells when injected into guinea pigs gave rise to specific growth inhibiting antibodies and a high degree of active immunity, without the development of positive reactions to the blood serum agglutination test.

After finding that a mucoid (M) strain of *Br. suis* caused no harmful effects when injected in large numbers into seven pregnant heifers, Huddleson and Bennet (157) vaccinated 22 infected herds and three brucellosis free herds with a vaccine prepared from the culture. Of 772 adult animals in the infected herds that were negative at the time of vaccination, 23 became positive reactors during the following 14 months period. Undoubtedly, some of the positive reactors had recently acquired natural infection and were in the incubation period of the disease at the time of vaccination. Thirty-three animals aborted, but only nine of them were positive for brucellosis. Twenty of 153 adult animals that were positive at the time of vaccination became negative before the end of one year. The disappearance of agglutinin titers in these animals was regarded as not significant. In the three blood test negative herds all of the 73 adult vaccinated animals reacted negatively at the end of the one year period of observation.
Clark and Phelps (158) vaccinated 899 blood test negative animals and 179 suspicious or positive reactors and concluded that M vaccine does not produce persistent blood serum agglutination reactions, and that the vaccine has no significant therapeutic value. Fifty-eight (6.3%) of the 899 vaccinated negative animals in infected herds were suspicious or positive when retested from three to 12 months after vaccination.

Field trials were reported by Killham et al. (159). In 117 vaccinated herds (2,402 cattle) the incidence of positive reactors was reduced (mainly by disposal of positive reactors) from 28 to 8 per cent during an average period of 11 months. In 311 unvaccinated comparison herds (2,927 cattle) the incidence decreased from 26 to 17 per cent during an average period of seven months.

Further observations were reported by Huddleson (160). Thirty-two pregnant heifers were added to three infected herds, 17 were vaccinated and 15 served as controls. During the following year none of the vaccinates became positive to the blood test, while eight of the controls became infected. Up to the time of this report, 71,000 doses of vaccine had been used with no evidence of harmful effects.

Observations on the use of M vaccine on adult cows have been limited largely to herds in Michigan. To-date a federal license for the commercial production of M vaccine for interstate shipment has not been issued. However, several states have set up experiments for testing the immunizing ability of M vaccine on heifers.

Two papers have been published on experiments in Ohio. Edgington and King (161) vaccinated eight cows with M vaccine and 11 with strain 19 vaccine. In the former group agglutinin titers up to 1:100 followed vaccination but receded to less than 1:25 within 164 days; and in the latter group titers up to 1:1600 followed vaccination and remained at 1:200 or above after 164 days. Both groups were bred following vaccination and exposed to infection when six to eight months pregnant. All of the cows in both groups calved normally. Following exposure, five of the M vaccinates reacted positively to the blood test and one shed Br. abortus in her milk. All of the strain 19 vaccinates continued to react to the blood test, however, cultural tests for Br. abortus were negative. Of the seven control cows that were exposed to infection three aborted, six reacted positively to the blood test, and Br. abortus was isolated from four.

In a subsequent experiment, Edgington et al. (162) divided heifers from eight to 15 months of age into three groups: six received M vaccine, five strain 19 vaccine, and six served as controls. Breeding was started about ten months after vaccination. During the fourth to sixth months of pregnancy, the animals were exposed to infection, by placing about 750,000 virulent Br. abortus organisms in the conjunctival sac. Three of the M vaccinates, none of the strain 19 vaccinates and five of the controls aborted or calved prematurely. The incidence of infection in the three groups was 50, 20, and 83.3 per cent, respectively. These results plus the results obtained on a second group of animals vaccinated when four to 13 months of age were described by Edgington and King (163). In the second group, the incidence of infection (following exposure) in nine M vaccinates, six strain 19 vaccinates and 11 controls was 77.8, 16.7 and 91.1 per cent, respectively. They concluded that 'While neither vaccine gave complete protection it is quite apparent, under conditions of
these tests, that strain 19 vaccine afforded a greater protective value than did M vaccine”.

Results of the West Virginia trials were reported in Hoard’s Dairyman, Jan. 25, 1951. Of 16 vaccinated heifers that were subsequently bred and exposed to infection, nine (56.2%) calved normally and all shed Br. abortus in their milk after calving. In comparison, four (28.5%) of the 14 controls calved normally and all showed udder infection.

A report on the work in Wisconsin appeared in Hoard’s Dairyman, Apr. 25, 1951. Following conception and exposure to infection the percentage of normal births for 57 M vaccinates, 38 strain 19 vaccinates, and 44 controls was 61, 92 and 43 per cent, respectively. The percentage of infection for the three groups was 53, 24, and 77 per cent, respectively. These results indicate that M vaccine confers some degree of resistance and that M vaccine is inferior to strain 19 vaccine for the vaccination of heifers.

Bryan et al. (164) compared the degree of protection given by Huddleson’s mucoid vaccine and strain 19 vaccine in five groups of heifers. The heifers were vaccinated when four to eight months of age, and exposed to infection (4 million to 14 million viable cells by conjunctival sac instillation) during the mid-gestation period. The results obtained in one group were not considered because of a lack of similarity to the other four groups. The results obtained in four groups (a total of 90 heifers) showed 35 per cent abnormal births for 31 strain 19 vaccinates, 79 per cent for 34 M vaccinates, and 88 per cent for 25 controls. Following exposure, positive agglutinin titers were obtained in 45 per cent of the strain 19 vaccinates, 82 per cent of the M vaccinates and 88 per cent of the controls. They concluded that under the conditions of the experiments, Huddleson’s mucoid vaccine failed to provide a “significant degree of resistance against brucellosis.” It should be pointed out, however, that the infective dose was larger than used in the Ohio experiments, and undoubtedly greater than would occur under natural conditions of exposure.

In general, it appears that M vaccine is preferable to strain 19 for the vaccination of adult cattle, and that strain 19 vaccine is definitely superior to M vaccine for the vaccination of heifers from six to eight months of age. The rapid expansion of calf vaccination with strain 19 vaccine, is decreasing the need for a vaccine for use on adult cattle.

Strain 19 Vaccine. The vaccine consists of live cells of an agglutinogenic culture of Br. abortus, designated as strain 19. The culture is of low virulence for cattle and guinea pigs and was isolated about 1923 at the Bureau of Animal Industry of the United States Department of Agriculture. It was selected by Buck (165) from many cultures tested, as best suited for vaccination of calves from five to eight months of age. Although the vaccine was developed for calf vaccination, and early research at the Bureau (Cotton et al. (166)) and in California (Haring and Traum (167)) showed that vaccination of mature cows occasionally resulted in udder infection, and abortion in cows in advanced pregnancy, adult vaccination has been widely used.

Undoubtedly the abortion rate may be reduced in some herds with spreading infection by a well planned program of vaccinating, once only, all adult blood test negative cattle when open or in the first five months of pregnancy, followed by calf
vaccination. However, it appears that the present trend toward restricting the sale
of milk for human consumption to blood test negative cows, the requiring of nega-
tive blood test reactions for cattle shipped interstate, and the increasing use of calf
vaccination, will eventually eliminate vaccination of adult cows. A few of the re-
ports on adult vaccination with S 19 vaccine will be mentioned.

An excellent discussion of the practical use of strain 19 vaccine was written by
Lothe (168). In actively infected herds he reduced the abortion rate and eventually
eliminated infection by (1) vaccinating all blood test negative open adult females,
(2) continuing with calf vaccination, (3) annual blood tests, and (4) gradual re-
placement of positive reactors with negative calf vaccinated animals. He expressed
the opinion that vaccination of sexually mature blood test negative cows should be
used only in herds where infection is active as a means of hastening the process of
building up herd immunity to the point where the disease can be eliminated, and
that the ultimate goal must be the establishment of a negative herd.

Haring and Tsun (169) obtained good results in 20 infected herds by vaccina-
tion of negative adult cows when open and later limiting vaccination to calves only.
The results in one heavily infected herd (34 adult cows) were as follows. In 1939,
calves over four months of age and all adult cows, except those pregnant at the
time, were vaccinated. Subsequently, calves only were vaccinated. The incidence
of blood test positive cows decreased from 55.6 per cent in 1940 to zero in 1943.
Reactors were removed because of poor production only. Some loss in milk produc-
tion, up to 20 per cent for several days, resulted from vaccinating lactating cows.

Less favorable results have been reported by others. Miller et al. (170) observed
that in one herd of 56 animals, adult vaccination appeared to check the spread of
virulent infection, however, in another herd the abortion rate remained about the
same after vaccination. Deem and Cross (171) vaccinated 60 mature beef
cows that
were pregnant (5 to 6 months) and negative to the blood test at the time of vaccina-
tion. During the following period of three months, 23 of the 60 aborted. Cultures
obtained from the two fetuses examined resembled strain 19. Moore and Mitchel
(172) vaccinated the blood test negative cows (1 to 11 yrs. of age) in 14 infected
herds. Data were obtained, at the end of the first pregnancy following vaccination
on 73 of the 188 animals that were vaccinated when nonpregnant, and 112 of those
that were vaccinated when pregnant. In the former group 96.9 per cent calved
normally and Br. abortus was demonstrated in the milk or uterine exudate of 20,
or 27.5 per cent, by inoculation of guinea pigs. In the latter group 85.7 per cent
calved normally and 24, or 21.4 per cent, were infected. McDiarmid (173) reported
five case of abortion in 42 pregnant cows that were in a recently infected herd, and
negative to the blood test at the time of vaccination.

Vaccination of adult cows by intradermal injection of from 0.02 ml. to 0.2 ml. of
strain 19 vaccine into the caudal fold was tried by Metzger and Shuart (174).
Vaccination was started in a herd of 130 cows and heifers following an outbreak of
brucellosis. The herd had been negative for brucellosis during the preceding seven
years. Following vaccination of 97 blood test negative adults, 14 became “probably
infected”, and 13 aborted. Cows were classed as “probably infected” on the basis
of a rise in agglutinin titer, positive agglutination tests on whey, and cultural
examination of colostrum and fetuses when available.
Mingle (175) vaccinated the adult animals in a self contained herd where infection was spreading; 115 by the subcutaneous route and 42 by injecting 0.2 ml. in the caudal fold. Of 81 pregnant animals in the subcutaneous group 6.1 per cent aborted from brucellosis, and in the intradermal group 10.3 per cent of 29 pregnancies ended in *Br. abortus* abortion.

The policy on adult vaccination that should be followed is given in the report of the Subcommittee on Brucellosis, Committee on Animal Health, National Research Council (Lambert *et al.* (176)). They stated that the ultimate goal of the livestock industry should be elimination of brucellosis from the animal population. In regard to vaccination of adult cattle, the Committee recommended that (1) in “problem herds” all calves and *Brucella* negative nonpregnant animals be vaccinated; (2) vaccination of mature cattle should be *used but once*; (3) vaccinated adult cattle should be handled as reactors in accordance with state and federal regulations, and (4) the use of strain 19 vaccine in adult cattle should be discouraged in brucellosis-free herds.

**Calf Vaccination with Strain 19**

_Early Research on Calf Vaccination._ The limitations of adult vaccination in brucellosis control, the finding of Rettger and White (6) that calves up to the time of approaching sexual maturity were naturally resistant to infection, and the observation of Smith and Little (177) that heifers injected with living cultures of low virulence protected them against infection, led to research which eventually resulted in our present calf vaccination program.

Buck (165) vaccinated 11 calves from five to eight months of age with three different lots of vaccine. The heifers were subsequently bred and exposed to infection. All of the vaccinates produced live calves. Three of the five controls aborted. One of the three animals vaccinated with a virulent culture, one of five vaccinated with vaccine made from cultures that had been maintained for eight years on artificial mediums, and three of five controls became infected. In comparison, all of the three animals given vaccine prepared from a moderately virulent culture, strain 19, resisted infection. Agglutinin titers in the strain 19 vaccinates were 1:3200 three weeks after vaccination. The titers then receded to 1:50 or less in eight months.

Comparison of the efficacy of vaccines made from cultures of low virulence (strain 11), medium virulence (strain 19), and high virulence (strain 484) was continued by Cotton *et al.* (166). Sixteen heifers (age not given) were vaccinated, bred from two to 11 months later, and exposed to infection (conjunctival method) when pregnant. Of five heifers given strain 11 vaccine, four calved normally, one died during calving, and two became infected. All of the five strain 19 and the six strain 484 vaccinates produced vigorous calves. One strain 19 vaccinate which was vaccinated three months before she was bred showed uterine infection. Seven of the eight controls aborted, and all eight showed uterine and colostral infection after calving. The use of strains of high virulence, such as strain 484, was considered highly objectionable because of the possibility of causing udder infection.

Of seven heifers vaccinated with an avirulent culture (strain 801), three aborted and two produced weak calves (Cotton *et al.* (143)).

Cotton *et al.* (178) vaccinated 17 calves (nine with strain 19 and eight with strain
(618) when four to six months of age and exposed them to infection via the conjunctiva after pregnancy was determined by rectal examination. The agglutinin titers had receded to less than 1:50 at the time of exposure. Sixteen of the 17 vaccinates produced vigorous calves and Br. abortus was isolated from the colostrum of two. One of the strain 618 vaccinates produced a weak calf and showed uterine and udder infection after calving. In comparison, six only of the 16 controls produced vigorous calves and ten became infected.

In a fourth trial Buck et al. (179) vaccinated six calves when six months of age and five yearlings (12 to 13 months of age). Breeding was started about 13 months after vaccination. One animal in each group was found not pregnant. The remaining vaccinates and 12 controls were exposed to infection (conjunctival method) during pregnancy. All of the nine vaccinates calved normally, and guinea pig inoculation results with uterine material and colostrum were negative. All of the calf vaccinates were negative at the time of calving, however, three of the four heifers that were vaccinated when 12 to 14 months of age gave titers of 1:100 and one gave a titer of 1:200. Of the 12 controls, one aborted, five produced weak calves, six produced vigorous calves, and eight were infected. They concluded that "The use of abortion vaccine in calves gives indication of having a distinct advantage over its use in more mature unbred heifers since in the former the Br. abortus agglutinins that are caused to appear in the blood serum by the vaccine injections disappear more promptly and more regularly."

The combined results of the four experiments conducted at the United States Bureau of Animal Industry show that of 53 calf vaccinated animals which were exposed to infection when pregnant, 96 per cent calved normally, and 13.2 per cent showed uterine or udder infection following parturition. In comparison 26 per cent of the 35 controls calved normally and 83 per cent became infected following exposure. In these experiments calf vaccination was about 84 per cent effective in protecting cattle against infection with Br. abortus.

Birch (180) and Birch et al. (181) conducted an experiment in which calf vaccinated and unvaccinated heifers were exposed to infection during the sixth to seventh month of pregnancy by keeping them in a pen in which virulent infectious material was maintained. During their first pregnancy, 2.8 per cent of the 35 vaccinates aborted and 8.5 per cent became infected. In comparison, 26 per cent of the 23 controls aborted and 60.8 per cent became infected. During their second pregnancy, 3.5 per cent of 29 vaccinates and 25 per cent of the 16 controls aborted. Birch commented that these results, and those of others, indicate that calf vaccination has a useful place when used in conjunction with present control programs, and that vaccination should be confined to calves.

Field Trials. Results of vaccinating calves with strain 19 vaccine under field conditions confirm the experimental findings.

A large scale field trial of calf vaccination with control groups was started by Hardenbergh (182) in 1935. First pregnancy records on 124 animals showed that 5.6 per cent aborted; 2.4 per cent from brucellosis and 3.2 per cent from other causes. Of 73 controls 6.2 per cent aborted from brucellosis. However, 9.8 per cent of the vaccinates became blood test positive following natural exposure, as compared with 20.5 per cent of the unvaccinated heifers.

Thomsen (183) vaccinated 328 calves from four to six months of age in six herds
in Denmark. The average incidence of abortion from brucellosis was 3.3 per cent for the vaccinates and 25.1 per cent for the 158 controls. In individual herds, the incidence of *Br. abortus* abortions among the vaccinates varied from zero to 9 per cent.

Thompskins (184), vaccinated calves at five to seven months of age in two infected herds. Unvaccinated calves were left as controls. The combined results on the two herds show that; of the 24 vaccinates five aborted, but none reacted positively to the blood test after calving; of the 32 controls four aborted, and 28.1 per cent were blood test positive after calving. These findings emphasize the importance of considering causes of abortion other than *Br. abortus* in evaluating calf vaccination. Sixty groups of calves in other herds were vaccinated during the period from 1934 to 1939. In these herds animals found positive to the blood test were removed immediately. Of 391 gestations in the vaccinated animals, 17 ended in abortion, and four animals were blood test positive at calving time. Two of the four positive reactors had remained positive after vaccination.

Lothe (168) was one of the first to demonstrate the practical use of calf vaccination in eliminating brucellosis. In one herd a program of calf vaccination, annual blood tests, and gradual disposal of positive reactors was started in 1932. By 1936, the last of the positive reactors had been removed.

Haring (185, 186) reduced the incidence of positive reactors in the San Quentin Prison Herd (43 cows) from 44 per cent in 1933 to one animal in 1938, by calf vaccination and disposal of positive cows after they were no longer economically valuable.

A large scale field trial was carried on by the United States Bureau of Animal Industry in 260 infected herds in 24 states, during the period from 1936 to 1941. At the start, an average of 29.2 per cent of the adult cows were positive to the blood test. From January 1936 to December 1940, 17,000 calves in these herds were vaccinated when from five to seven months of age. The results up to 1940 were given by Mohler et al. (187). At this time the records available on 8,182 calvings showed that 7,872 or 96.2 per cent, were normal. Of the normal calving animals, 82.9 per cent were negative, 12 per cent were suspicious, and 5.1 per cent were positive on postparturition blood tests. Of the 310 animals which aborted 58.7 per cent were negative to the blood test.

Results of six years experience with calf vaccination in infected herds in New Zealand were reported by Buddle (188). Of 182,247 pregnancies in vaccinated animals, 2.6 per cent terminated in abortion. Records on these herds before calf vaccination showed an abortion rate of 18.8 per cent in heifers and 6.8 per cent in older cows.

**Effect of Vaccine on the Calf.** The immediate response of calves to the subcutaneous injection of the vaccine varies from no reaction to a marked rise in body temperature, up to 108°F., and loss of appetite for a period of several days. Some local swelling may occur. (Buck (165), Thomsen (183), and Hardenbergh (182)).

**Vaccination of Bull Calves.** As pointed out by Kingman (189) there appears to be no valid reason for vaccinating bull calves. Most bull calves are either slaughtered, or offered for sale at an age when they are still suspicious or positive to the blood test as a result of vaccination. Dalling (190) stated that bull calves should not be
vaccinated. Danks (191) described a case of orchitis in a two year old calf vaccinated bull. A culture isolated from the testicle was identified as *Br. abortus* strain 19.

**Degree of Resistance.** In general, the results of experiments and field trials indicate that calf vaccination protects about 97 per cent of animals against abortion *from* brucellosis and about 80 per cent against infection. However, exposure to large numbers of virulent *Br. abortus* organisms may overcome the resistance of calf vaccinated animals. This is shown by an experiment conducted at the United States Bureau of Animal Industry. The results showed that the incidence of infection following conjunctival exposure of calf vaccinated animals to 15,000,000; 741,000; and 370,000 virulent organisms was 72.7, 22.2 and zero per cent, respectively (From Ann. Rpt. of the B.A.I. Abstract in Vet. Med., 44: 1949, p. 251).

In Connecticut, vaccination of calves from six to eight months of age has been required since 1945. Vaccine prepared by freeze-drying *in vacuo* has been used since 1946. The incidence of positive reactors in herds on initial test during the period from 1925 through 1953 was reported by Plastridge et al. (45). The results show that the incidence of infection was reduced from about 20 to 5 per cent through calf vaccination. The five per cent of infection in these herds and the occasional appearance of infection in blood test negative calf vaccinated herds emphasize the need for large scale testing and removal of positive reactors.

The ideal age for vaccination is between six and eight months. It is generally agreed that calves under six months of age develop less resistance from the vaccine than older ones, and that calves over nine months of age tend to retain vaccinal blood titers.  

**Duration of Resistance.** In general, the results of experiments and field trials show that resistance induced by calf vaccination does not decrease with time, although the results of several experiments have suggested that resistance decreases after the first pregnancy.

In Buck's (165) first experiment all of the 11 calf vaccinated heifers which were exposed to infection when pregnant, calved normally at the end of their first pregnancy, and during their second pregnancy one aborted but not from brucellosis. Two were infected at the end of the first pregnancy and one at the end of the second. The results of Cotton et al. (178) were similar. Of 16 calf vaccinated heifers which were exposed to infection in their first pregnancy, 15 calved normally and two were infected following parturition; and of ten heifers continued on experiment during their second pregnancy all calved normally and two were infected.

Wight (192) reported the calving records of calf vaccinated animals in the 260 infected herds in the federal experiment. The results were as follows:

<table>
<thead>
<tr>
<th>Pregnancy</th>
<th>Number of Animals</th>
<th>Per Cent Aborted</th>
<th>Per Cent Positive to the Blood Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1242</td>
<td>1.9</td>
<td>4.1</td>
</tr>
<tr>
<td>2</td>
<td>926</td>
<td>3.1</td>
<td>2.4</td>
</tr>
<tr>
<td>3</td>
<td>742</td>
<td>1.5</td>
<td>3.1</td>
</tr>
<tr>
<td>4</td>
<td>334</td>
<td>2.1</td>
<td>4.2</td>
</tr>
<tr>
<td>5</td>
<td>80</td>
<td>6.2*</td>
<td>1.3</td>
</tr>
</tbody>
</table>

* One only of the five abortions were due to brucellosis.
Birch et al. (193) placed calf vaccinated animals in different pregnancies in an "exposure" barn in which known infected cows were kept. The percentage incidence of abortions in animals in their first, second, third, fourth, fifth, and sixth pregnancies was 2.2, 2.7, 3.2, 15.4, 0.0 and 0.0, respectively. The percentage of infection (uterine swabs or milk positive) was 15.6, 18.9, 9.7, 38.5, 0.0, and 0.0, respectively.

Beach et al. (194) exposed 23 calf vaccinated animals in their third gestation by by instilling 35,000,000 virulent organisms into the conjunctival sac. Twelve of the cows aborted and 18 became infected. All of the ten controls became infected and aborted. First pregnancy animals were not used for comparison. Experiments at the United States Agricultural Research Service indicate that the heavy exposure used may have produced as high an incidence of infection if used on first pregnancy animals.

Manthei et al. (195) exposed five separate experimental groups of calf vaccinated animals to infection during their first, second, third, fourth and fifth pregnancies, respectively. The results obtained showed that resistance did not decrease with time. In fact, the older animals appeared to be more resistant to artificial conjunctival exposure than the young ones.

Revaccination. In California revaccination has been recommended and practiced when infection begins to appear in calf vaccinated animals (Haring (185), Haring and Traum (169)). The results already described on duration of resistance and the results obtained in Connecticut where calf vaccination has been compulsory since 1945 (Plastridge et al. (45)) show that there is little need for revaccination when good quality vaccine is used to vaccinate calves at the age of six to eight months.

Revaccination of heifers, after their blood titers had returned to negative, resulted in positive blood titers for a period of about four months and persistent suspicious reactions thereafter, in an experiment conducted by Berman and Beach (196). These animals were later exposed to infection by Berman et al. (197). The percentage incidence of infection for 18 controls was 94 per cent, for 14 animals vaccinated at eight months 21 per cent, for 18 animals vaccinated at eight months and again at 14 months 28 per cent, and for 16 animals vaccinated at eight months and again at 20 months 25 per cent. These results indicate that no increase in resistance resulted from revaccination.

Agglutination Reactions Resulting from Calf Vaccination. The proportion of calf vaccinated heifers which react positively or suspiciously after they are two years of age depends largely upon (1) extent of natural exposure to infection following vaccination, and (2) age at time of vaccination. In the absence of natural exposure, less than 0.5 per cent of heifers vaccinated when six to eight months of age react positively after they have reached two years of age.

Average agglutinin titers of calves vaccinated with strain 19 vaccine when four to eight months of age by Buck (165), Cotton et al. (178) and Buck et al. (179) were 1:2000 two to three weeks after vaccination. The titers receded to 1:50 or less, within one year, or before the heifers were exposed to infection. Hardenbergh (182) vaccinated 625 calves when four to nine months of age and observed that the mean titer ten days after vaccination was 1:800, and that 12 months after vaccination 80.6 per cent were negative, 19.2 per cent suspicious and 0.2 per cent positive to the blood test. Haring et al. (198) observed the blood test reactions of 814 cal
vaccinated heifers in a brucellosis-free herd. Following their first parturition 91 per cent reacted negatively, 8.5 per cent suspiciously and 0.5 per cent positively.

Tompkins (184) blood tested 222 calf vaccinated heifers raised in herds producing certified milk. Following their first parturition, nine (4.0 per cent) reacted suspiciously and three (1.4 per cent) positively. Two of the three animals remained positive after vaccination.

The incidence of persistent positive reactions in calf vaccinated heifers is increased when the animals are maintained in infected herds. Birch et al. (193) observed that post-vaccination reactions endured more than nine months in 22.2 per cent of 45 calf vaccinated heifers which were kept under experimental conditions that provided frequent exposure. Under field conditions, the incidence is lower. Of 1,242 calf vaccinated heifers in the United States Agricultural Research Service field trial in 260 infected herds, 4.1 per cent were positive when blood tested after their first calving (Wight (192)). Thompson (199) reported that when young cows, vaccinated as calves, are exposed to infection 8.5 per cent will react positively; 3.5 per cent as the result of vaccination and 5.0 per cent from exposure to natural infection.

Age at the time of vaccination affects the persistence of agglutinin titers. Haring and Traum (200) observed the blood test reactions of large numbers of animals vaccinated at different ages. The percentages of animals with negative agglutinin titers 24 months following vaccination were as follows; vaccinated at four to eight months—99 per cent, vaccinated at eight to 12 months—91 per cent, vaccinated at 12 to 16 months—83 per cent, and unbred heifers vaccinated when over 16 months of age—50 per cent. Haring and Traum (169) reported the persistence of agglutinins in 752 animals. The animals were divided into five age groups at the time of vaccination; four to six months, six to eight months, eight to ten months, ten to 16 months, and cows and heifers over 16 months of age. The percentage of animals in each group that were negative to the blood test 24 months after vaccination was 100, 90, 75, 60, and 15 per cent, respectively.

No agglutination reaction following vaccination occurs in a few animals. Birch et al. (193) observed one animal that showed no agglutinin response to the original vaccination nor to a second. She apparently possessed a high degree of natural resistance, since she terminated four pregnancies without showing evidence suggesting brucellosis although she was in frequent contact with known infected cows.

Agglutinin Response of Calf Vaccinated Animals to Exposure to Infection. When exposed to infection, heifers and cows that have become blood test negative following calf vaccination may either remain negative, develop transient suspicious or positive reactions, or become permanent reactors, depending on the degree of exposure and resistance of the animal.

Of the 11 calf vaccinated heifers which were exposed to infection in Buck's (165) original experiment, two developed positive titers which persisted to the end of the two year period of observation and nine remained negative. Br. abortus was isolated from the two positive reactors.

Cotton et al. (178) observed that 17 experimental calf vaccinated heifers gave titers of 1:50 to 1:500 when tested 15 days after conjunctival exposure, and later returned to a blood test negative or suspicious status within a period of three months.
In comparison, all of the controls that developed positive reactions following exposure remained positive for the duration of the experiment.

In an experiment conducted by Manthei et al. (195), the number of calf vaccinated animals that become positive and the maximum titers obtained following exposure, were directly proportional to the degree of exposure.

From these observations it appears that it may be desirable to retest calf vaccinated cattle that develop a positive reaction, especially those with titers of 1:100.

**Intradermal Vaccination.** Several investigators have reported that the agglutinin and opsonocytophagic response is just as strong when calves are injected with small amounts of vaccine intradermally, as when they are given the usual 5 ml. dose subcutaneously. The findings of Le Grow (201) indicate that the opsonic index, of itself, is not a criterion on which to base expectations of immunity or susceptibility. Mingle (175) states that the significance of agglutinins and opsonins in judging resistance has been overestimated. Recent experiments in which resistance was tested by exposure to infection, indicate that the intradermal and subcutaneous methods of vaccination confer about the same degree of immunity.

Rabstein and Cotton (202) vaccinated 29 calves by injecting 0.2 ml. of strain 19 vaccine into the caudal fold, and 12 calves by the usual subcutaneous injection of 5 ml. of vaccine. Blood samples were collected periodically and examined for agglutinins and by the opsonocytophagic test described by Huddleson (2). Two weeks following vaccination, agglutinin titers and opsonocytophagic reactions were similar in both groups. At the end of three months the agglutinin reactions of all of the calves which were vaccinated intradermally were negative; and 50 per cent of the calves which were vaccinated subcutaneously reacted suspiciously or positively. Similar results were obtained by Cotton (203) on a larger number of animals. As in the original experiment, resistance of the vaccinated animals was not tested by exposure to infection.

Mc Diarmid (204) vaccinated heifers when 15 to 18 months of age. The heifers were then bred. Those which conceived were exposed to infection at about the fifth month of pregnancy. The incidence of infection following parturition was as follows; one of eight vaccinated subcutaneously, one of 10 vaccinated with 0.2 ml. intradermally, and one of 10 vaccinated with 1.0 ml. intracaudally. All of the 12 controls became infected. Mc Diarmid concluded that intradermal and intracaudal vaccination conferred an immunity comparable to that produced by the subcutaneous method.

Gregory (205) vaccinated calves when seven to ten months of age; 62 by the subcutaneous method and 67 by the intracaudal method. The mean maximum agglutinin titer following vaccination was 1:423 in the former group and 1:793 in the latter group. There was no significance difference in the proportion of animals returning to a negative status after 12 months. Later Gregory (206) exposed about 40 animals in each group to natural infection during their first pregnancy. When results in the control group were taken as an indication of expected rates of abortion and infection, it was found that there was a reduction in the abortion rate of about 87 per cent in the intracaudal group and about 71 per cent in the subcutaneous group. The difference was not statistically significant. Gregory concluded that the intracaudal method was as effective as the standard subcutaneous method.
Manthei *et al.* (207) vaccinated 41 heifers between 12 and 13 months of age; 21 with 0.2 ml. intradermally, 14 with 5 ml. subcutaneously, and six with 0.2 ml. subcutaneously. The percentage of animals with agglutinin titers below 1:100 when tested 78 weeks after vaccination was 52 per cent for the intradermal group, 36 per cent for those that received 5 ml. subcutaneously, and 50 per cent for those that were injected with 0.2 ml. subcutaneously. The degree of resistance to subsequent exposure to infection was similar in all three groups and was not related to the post-vaccinal agglutinin response.

Additional data were reported by Manthei (208). In calves vaccinated when four to eight months of age, the percentage that reacted positively 12 months after vaccination was 3.8 per cent for those vaccinated subcutaneously, 1.0 for those vaccinated intradermally, and 9.4 per cent for those injected with 1 ml. intracaudally. There was no significant difference in the degree of immunity produced by the three methods.

On the basis of immunity response and persistence of agglutinins, there appears to be no distinct advantage of the intradermal and intracaudal methods of vaccination over the usual subcutaneous method. Under practical conditions intradermal injections are more difficult to make than subcutaneous injections. Moreover, the smaller amount of vaccine used in the intradermal method results in less uniformity in the dose given, owing to a greater chance for variability in the volume injected and to differences in the number of viable cells in different lots of vaccine, especially when "liquid" vaccine is used.

**Abortion in Calf Vaccinated Animals.** Abortion is not necessarily evidence of failure of calf vaccination to protect against brucellosis.

In the United States Agricultural Research Service field trial, involving 8182 parturitions, 31.9 per cent only, of the 310 animals which aborted, reacted positively to the blood test for brucellosis (Mohler *et al.* (187)). In the New Zealand field trial (Buddle (188)), about half of the abortions in calf vaccinated animals were attributed to brucellosis. Hardenbergh (182) observed an abortion rate of 5.6 per cent, 2.4 per cent due to brucellosis and 3.2 per cent due to other causes, in calf vaccinated heifers.

In Connecticut, of 808 fetuses examined, the majority of which were from calf vaccinated animals, 11 per cent were infected with *Br. abortus* (Plastridge *et al.* (45)). Annual abortion rates of from four to 30 per cent in brucellosis-free animals have resulted from vibriosis (Plastridge *et al.* (209)).

Kerlin and Graham (210), reported an abortion rate of 37 per cent in a herd of 35 calf vaccinated heifers. However, of six fetuses examined two, only, yielded *Br. abortus*.

**CHEMOTHERAPY**

A long list of chemicals starting with carbolic acid in 1884 have been tried without success in the treatment of bovine brucellosis. From 1900 to 1940 many so-called cures gained popularity because of an apparent reduction in the abortion rate following their use at the height of an "abortion storm". A review of reports on chemotherapy in bovine brucellosis was given by Mohler *et al.* (187). Some of the proprietary remedies, particularly "3-V Tonic" and "Bowman's" product, were
investigated by the United States Bureau of Animal Industry and found ineffective (Crawford and Beach (211)).

More recently sulfonamides and antibiotics have been tried. Live et al. (212, 213) demonstrated that sulfapyridine and sulfathiazole failed to remove Br. abortus from bovine udders. Penicillin was found ineffective by Berman et al. (214). Aureomycin failed to eliminate udder infection in five lactating cows treated by Manthei (8).

**STATE PROGRAMS**

Research conducted during the period from 1920 to 1930, particularly in Colorado, Connecticut, Minnesota, and Pennsylvania, demonstrated that progress could be made in eradicating brucellosis by systematic blood testing and segregation of positive reactors. Subsequently many states established control programs which provided for periodic blood testing of herds, segregation and disposal of positive reactors, restrictions on imports and use of vaccines, reporting of the results of blood tests to a central state disease control agency, and certification of herds free from brucellosis.

*Test and Slaughter Program.* In 1934, the 73rd Congress enacted the Jones-Connelly Bill making funds available for use in eliminating brucellosis in cattle. Cooperative state-federal programs were instituted in many states. Under this program positive reactors were slaughtered, and the federal government provided maximum indemnity payments of 25 dollars for grades and 50 dollars for pure-bred registered cattle. A few states provided additional funds.

In 1939, Congress provided that federal payments of indemnity must be matched by state funds.

In some states provision was made for area testing under which a county became "modified-certified" when the incidence of infection was reduced to not more than 1 per cent of the total cattle population, with the further qualification that not more than 5 per cent of the herds were infected. Crawford (215) reported that 591 countries in 22 states were on the modified-certified list.

With the aid of the test and slaughter program, Maine, New Hampshire, and North Carolina became modified-certified states. However, in states like Connecticut, with a higher incidence of infection and in which about one-third of the herds are maintained by imported cattle, the test and slaughter program alone has been inadequate and too expensive for eradicating brucellosis on a large scale.

*Official Recognition of Calfhood Vaccination.* The federal government, in 1940, recommended acceptance of calf vaccination, as an adjunct to the test and slaughter method (Mohler et al. (187)). This led to the adoption of three basic control plans by most of the states (Crawford (215)):

- **Plan I.** Test and slaughter with payment of indemnity.
- **Plan II.** Same as Plan I plus calfhood vaccination.
- **Plan III.** "Test and Hold" plus calf vaccination, with no indemnity for the reacting animals retained. Under this plan annual or more frequent blood tests of the entire herd, except calf vaccinated heifers under two years of age, are made and positive reacting animals are eliminated when calf vaccinated replacements become available.
The Committee on Brucellosis of the United States Livestock Sanitary Association, in 1949, outlined in detail recommendations for state legislation under which Plans A, B, and C would function. Plan IV (adult vaccination) was included with the recommendation that adult vaccination should be done only under special permit and in herds where there is evidence of rapid spread, that blood test negative animals only be vaccinated, and that if moved out of the herd adult vaccinated animals shall be classed as reactors.

The control plans have been revised as follows:

Plan A. Test and slaughter usually with payment of indemnity and calfhood vaccination.

Plan B. Test and hold with calfhood vaccination and gradual elimination of reactors with no indemnity.

Plan C. Vaccination of calves. No testing.

Plan D. Test and hold; once vaccinating negative adults; calfhood vaccination; gradual elimination of reactors with no indemnity.

As pointed out by Gilman (216) no one plan is best suited to all herds, and the "logical approach to brucellosis eradication in a herd consists of a plan suited to that individual herd. The plan selected may include, as it develops, calf vaccination, test and slaughter, or test and gradual elimination. These may be applied singly or in combination, concurrently or successively, but always with the same objective—a clean herd."

Compulsory calf vaccination has been adopted by some states. Connecticut was one of the first to do so, in 1945. Information on progress made under this program was presented by Plastridge et al. (45). The Connecticut results showed that in herds in which replacements were raised, the incidence of positive reactors was reduced from about 20 per cent to less than 5 per cent by calf vaccination alone, and that about 80 per cent of the 1085 herds on initial test during 1951, 1952, and 1953 were free of positive reactors on their first test.

The Committee on Brucellosis of the United States Livestock Sanitary Association in 1951 recommended that an area be declared a "modified certified brucellosis-free area" when a blood test of all cattle within an area shows that the number of reactors (exclusive of officially vaccinated animals under 30 months of age) does not exceed one per cent and the herd infection does not exceed five per cent.

Recent State Regulations. Kuttler (217) reported that 24 states now have laws or regulations which will permit the livestock authorities of the state to require the testing of all cattle in a given area after a majority of the owners have voluntarily placed their herds under supervision. His report indicates that in 1951 about 14 per cent of the 40,000,000 breeding cows in the United States were tested, and about 25 per cent of the calves were being vaccinated.

Several states have passed laws setting dates after which milk for human consumption must come from brucellosis-free animals. A list of such states with the effective date was compiled by Kuttler (118) and is as follows: Connecticut (not later than January 1, 1960, not included in Kuttler's list); Illinois (all Grade A milk producers by January 1, 1955); Montana (January 1, 1954); Nevada (1940); New Jersey (April 1, 1958); North Carolina (July 1, 1952); and South Carolina (1955). Other states which have set dates after which all herds must be under state and
federal supervision are: Alabama (1957); Florida ("several years ago"); Minnesota (January 1, 1955); Ohio (1956); Oregon (now in effect); Pennsylvania (January 1, 1957); and South Dakota (June 1, 1953). Wisconsin expects to be a brucellosis-free state by 1955.

The "Milk Ordinance and Code—1953 Recommendations of the Public Health Service" recommends a new ordinance that would require that within a period not to exceed three years, all milk or milk products for pasteurization must come from herds certified by the state livestock sanitary authority as following either Plan A or Plan B approved by the Agricultural Research Administration for the eradication of brucellosis (Helvig, (218)).

Maine, New Hampshire, and North Carolina are already modified certified brucellosis-free Areas.

SUMMARY

This report gives information on the effect of brucellosis on cattle, ways the disease is transmitted, methods of diagnosis, control by the use of blood tests and segregation or slaughter of reactors, adult vaccination with different types of vaccine, results obtained with calf vaccination, and recent regulations requiring brucellosis-free herds for the production of milk for human consumption.

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RELATIONSHIP OF SERO-AGGLUTININ TITERS TO UDDER INFECTION IN STRAIN 19 VACCINATED CATTLE

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Since the initiation of vaccination of cattle with Brucella abortus strain 19 in 1940 as an adjunct to the State-Federal programs of brucellosis control and eradication in this country, the need for information that will make possible the correct determination of the brucellosis status of vaccinated animals with low agglutinin titers has increased with the vast number of animals vaccinated.

With the decline of bovine brucellosis from 6.8 per cent in the fiscal year 1936 to 2.6 per cent in the fiscal year 1954, as determined by the blood serum agglutination test, the number of vaccinated and nonvaccinated animals with low or fluctuating blood serum agglutinin titers has taken on a new significance. It is this group of animals that confounds the herd brucellosis status throughout the country with regards to conforming with present and proposed health department milk ordinances and interstate regulations for shipment of breeding cattle.

This experiment was designed to develop information on the relationship between blood serum agglutinin titers and udder infection in calf-vaccinated cattle.

Since Schroeder and Cotton (5) in 1912 reported the isolation of Brucella abortus from milk by means of guinea pig inoculation, most investigators of brucellosis have to some degree made direct culture and guinea pig inoculation studies along these lines. It is impractical to discuss the large number of publications on this subject at this time. Although studies of direct culture and guinea pig inoculation of milk have been conducted to attain information relative to many different problems concerning brucellosis, most reports deal with nonvaccinated animals. The results of these studies are very similar when the status and source of the animals and conditions of the experiments are considered.

It was felt that direct culture and inoculation of guinea pigs with quarter samples of milk from the cows studied in this experiment would give us a fairly reliable and consistent means of identifying infected animals that were excreting Brucella from the udder. This is based on an isolation rate of 100 per cent from the milk (quarter samples) collected under ideal conditions at weekly intervals from two groups of infected cows. Milk was collected for four weeks from four cows and for seven weeks from three cows. We appreciate that when a single milk collection is used to identify infected animals, 100 per cent accuracy is seldom attained because of unfavorable conditions frequently encountered in the field. Regardless of this it would not alter the trend of relationship of isolations to blood serum titers. Furthermore, we believe that the suggested procedure is the most practical method that can be applied in a study of this kind.

EXPERIMENTAL PROCEDURES

Blood and milk from 740 cows of all dairy breeds as well as the crossbreeds usually found in milk producing areas of this country were examined. These cows were from
278 herds containing 6,276 adult cows. In each herd selected, all animals showing a significant reaction in the 1:50 or higher dilution of the standard sero-agglutination tests for brucellosis were studied. Results of the last test conducted by the State-Federal disease control organization, which in most cases was approximately 30 days prior to our sample collections, were used in selecting herds and cows for this study.

In the first part of the experiment, studies were conducted on 263 cows from 180 herds in Jersey County, Illinois. This county had been participating in an intensive calf-vaccination program since 1942, or approximately ten years prior to this study. According to information furnished by Dr. A. K. Kuttler's office, the cows in this county were blood tested only at the beginning of the program in 1942 and at intervals of five years thereafter to evaluate progress in control of brucellosis. Animals were eliminated only by natural cause and when they became unprofitable.

After completion of this part of the experiment it was thought advisable to also study cattle from an area where the herds were larger, the percentage of infection was higher, and where there was a variation in brucellosis control measures, i.e. test and slaughter, calf-vaccination, or a combination of both and no control efforts in some cases. New York State was selected as the area to conduct the second part of the experiment. Examinations were made on 477 cows in 98 herds.

All of the cattle from both areas were from herds containing reactors or suspects with 70.3 per cent of the vaccinated and 70.8 per cent of the nonvaccinated ones from herds harboring reactors. The average age at time of vaccination was 8.7 months.

Quarter samples of udder secretion were collected aseptically from cattle of various ages (2 to 12 years), in all stages of lactation, and in some cases from non-lactating cattle. The amount of secretion collected was 30 ml. when available. The udders were washed with a solution of quartinary ammonium compound, rinsed with clear water and wiped dry. The teats were then cleansed with a pledget of cotton soaked with 70 per cent alcohol; special attention being given to the orifices of the teat canal. Two or three streams of milk were discarded before collection of the sample. A 30 ml. sample of blood was drawn from the jugular vein at the time of milk collections. Milk and blood samples were placed under refrigeration and shipped by air express to the Animal Disease Station within 24 hours after collection.

The blood samples were centrifuged and serum was separated from the clot. A portion of each serum sample was subjected to the standard tube and plate agglutination tests for brucellosis. The remainder of each serum sample was stored for future studies on specific and nonspecific agglutination reactions.

Milk samples were allowed to stand at refrigerator temperature over night so the cream could rise. Petri dishes containing serum potato agar medium were inoculated with 0.2 ml. of cream from each sample. The inoculated medium was then incubated at 37.5°C. in an atmosphere of 10 per cent carbon-dioxide for seven days at which time observations were made for the presence of Brucella colonies.

Immediately following inoculation of the medium, the remaining cream and sufficient quantity of milk and sediment from each sample to make up 5 ml. was injected intraperitoneally into guinea pigs. Each quarter sample collected in Illinois was inoculated into two guinea pigs, whereas each quarter sample collected in New York was inoculated into one guinea pig.
When sufficient quantities were available, a portion of each quarter sample was treated with rennin for subsequent tests to determine the presence of \textit{Brucella} agglutinins in the whey. The milk ring test was conducted on composite quarter samples of milk from each cow tested in Illinois and on can samples of milk from each herd tested in New York. The milk from Illinois was tested in our laboratory and that from New York in the State laboratory at Albany.

All guinea pigs inoculated with udder secretion from each cow were isolated in a separate cage for approximately 35 days. They were then sacrificed, autopsied, and observed for any gross lesions indicative of brucellosis. A blood sample was taken from each pig and tested for \textit{Brucella} agglutinins. The spleen of each pig was removed and cultured as were other organs or lymph nodes suspected of localized infection. These tissues were cultured directly on serum potato agar slants and incubated in the same manner as that employed for direct culture of cream.

Suspicious colonies observed during any of the culturing procedures were subcultured so that they could be examined for staining characteristics, motility, antigenicity, CO\textsubscript{2} requirement, and cellular and colonial morphology. All isolations of \textit{Brucella} were further examined for dye inhibition, urease activity, hydrogen sulphide production, and antigenic activity with monospecific sera in order to classify them according to specie.

Every effort was made to obtain a complete history of each herd and animal. This information included number of adult animals, previous blood tests, method of adding or replacing animals, number of years that calf-vaccination had been practiced, number of abortions, vaccination and present age of each animal and stage of lactation. Any animal whose vaccination status was not clearly established was omitted when results were compiled.

### RESULTS

Isolations of \textit{Brucella} were made from the milk of cows in all stages of lactation and in some cases from the scant secretions of nonlactating animals. The types of udder infection differed in that some were apparently disseminating \textit{Brucella} from only one quarter, whereas others from two or more quarters.

All isolations were virulent strains of \textit{Brucella abortus}. Thirteen of the 51 isolations were atypical in that they were inhibited by routine and in most cases by lesser concentrations of basic fuchsin and methyl violet used for typing \textit{Brucella}. Their reactions to other typing procedures and mono-specific sera were typical of virulent \textit{Brucella abortus}. Twelve of these atypical \textit{Brucella abortus} isolations were obtained from cows in New York and one from a cow in Illinois. The organisms were similar to those first described by Wilson (6), and more recently reported by Huddleson (3, 4). However, they were not associated with mastitis at the time of isolation.

The results of studies on relationship of blood serum agglutinin titers to isolations of \textit{Brucella abortus} from milk of calf-vaccinated and nonvaccinated cows are shown in Table I. Although it was not our intention to conduct studies on animals with sero-agglutinin titers lower than 1:50, there were some vaccinated and nonvaccinated animals whose titers had receded below this level since the pre-milk-collection test. No isolations of \textit{Brucella} were made from the milk of vaccinated cattle with titers less than 1:100 nor from nonvaccinated cattle with titers less than
TABLE I

<table>
<thead>
<tr>
<th>Blood Serum Agglutinin Titers</th>
<th>Vaccinated</th>
<th>Nonvaccinated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of cows</td>
<td>No. Br. negative</td>
</tr>
<tr>
<td>-1:25</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>I 1:25</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>+1:25</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>I 1:50</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>+1:50</td>
<td>236</td>
<td>236</td>
</tr>
<tr>
<td>I 1:100</td>
<td>109</td>
<td>107</td>
</tr>
<tr>
<td>+1:100</td>
<td>94</td>
<td>92</td>
</tr>
<tr>
<td>I 1:200</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>+1:200</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>I 1:400 or higher</td>
<td>33</td>
<td>11</td>
</tr>
</tbody>
</table>

- = no agglutination reaction in dilution shown; I = incomplete agglutination reaction in dilution shown; + = complete agglutination reaction in dilution shown; Dil. = dilution.

+1:50. Of animals classified as suspects (titers of I 1:50 to I 1:100 inclusive) Brucella was isolated from 0.51 per cent of the vaccinated and 2.7 per cent of the nonvaccinated cattle. Furthermore, udder infection was demonstrated in 15.34 per cent of the vaccinated reactors and 48.93 per cent of the nonvaccinated reactors. However, in both classes of animals with titers of I 1:400 or higher, the percentages of demonstrable udder infection were almost equal. The percentage of infection in vaccinated cattle at the various titer levels was approximately the same in all age groups. To summarize, Brucella was isolated from the milk of 29 of 637 vaccinated cattle or 4.55 per cent as compared to 22 of 103 nonvaccinated cattle or 21.35 per cent.

Efforts to determine changes in titers of suspects and low-titer reactors subsequent to isolation of Brucella were unsuccessful because in each case these animals had been removed from the herd.

Figure 1 shows more graphically the relative trend of Brucella isolations to the sero-agglutinin titers of both vaccinated and nonvaccinated cattle. No isolations of
**FIG. 1. RELATIONSHIP OF SERO-AGGLUTININ TITERS TO PERCENTAGE OF INFECTION.**

*Brucella* were made from the milk of vaccinated cows with titers of $1:200$ or from nonvaccinated cows with titers of $1:100$. However, since *Brucella* was isolated from cows with titers at the preceding and succeeding levels, it is logical to assume that udder infection could have been demonstrated if adequate numbers had been available. Therefore, the probable percentages of *Brucella* isolations that may be expected were calculated by applying the formula for geometric progression. These calculated percentages are almost identical. The percentage of infection was approximately two to four times greater in the nonvaccinated than in the vaccinated group at each titer level shown except for those animals with titers of $1:400$ or higher. The most precipitous rise in percentage of infection began with the $+1:100$ titer in nonvaccinated and $+1:200$ titer in vaccinated cattle.

Although the number of nonvaccinated cattle examined was limited, our results compare favorably with those reported by Everson et al. (1) who examined blood and udder secretions of 714 cows, and where the majority of conditions were similar.

An extremely significant finding is that all but 1 of 51 *Brucella*-positive cows were from herds which contained one or more animals with a maximum sero-agglutinin titer of $1:400$ or higher. The one exception was a ten-year old nonvaccinated cow with a titer of $+1:50$ and was in a herd of 30 cows where the maximum individual sero-agglutinin titer was $1:100$. The origin of this animal is unknown; however, the history of the herd shows that there was no record of a previous agglutination test, calfhood vaccination had been practiced for the last 8 years and at least 50
per cent of the cattle replacements were purchased. Another important observation is that 73.07 per cent of the 26 herds containing bacteriologically positive cattle were supplemented by purchased replacements.

The results of the milk ring test on can samples from 96 of the 98 herds studied in New York are presented in Table II. All except 1 of the 17 herds containing bacteriologically positive cows had milk reactions of 2+ or higher. This one exception contained 58 adult cattle; six of which had titers no higher than +1:100 whereas the remaining one had a titer of +1:1600 and was bacteriologically positive. Failure of the milk ring test to identify this infected herd is difficult to explain since all of the quarter milk samples from the infected cow had whey titers of +1:100 or +1:200.

Sixty-two of the 79 bacteriologically negative herds samples were negative to the ring test; whereas, 12 showed reactions of 2+ or higher and 5 showed reactions of 1+. Summarily, the ring test conducted on herds practicing calf-vaccination correctly identified 94.12 per cent of those that were bacteriologically positive and 78.5 per cent of those that were bacteriologically negative.

The efficiency of the milk ring test for properly identifying herds that have been classified by the standard sero-agglutination test was also evaluated. In the herds containing cattle with maximum titers of I 1:100 or less, 92.31 per cent were classified as brucellosis-free by the milk ring test; however, it also classified 37 of the 48 or 77.08 per cent of the herds with maximum titers of +1:100 to +1:200 inclusive as negative. Therefore, the milk ring test results were in closer agreement with the bacteriological findings than the serological findings in calf-vaccinated herds with maximum titers of +1:100 to +1:200. Nevertheless this test identified 90.09 per cent of the herds with maximum sero-agglutinin titers of I 1:400 or higher as infected which also compares favorably with the bacteriological findings.

The milk ring test was not conducted on a herd basis in Jersey County, but composite quarter samples of each cow were examined. In each case where Brucella isolations were made, the milk was positive to the ring test. Results of the ring test on individual cows have been disregarded because of the high percentage of positive reactions in the milk of bacteriologically and serologically negative animals. The

### Table II

*Correlation of Milk Ring and Sero-Agglutination Tests to Isolations of Brucella abortus from Milk*

<table>
<thead>
<tr>
<th>Maximum Milk Ring Reaction in Each Herd</th>
<th>Maximum Sero-Agglutinin Titer in Each Herd</th>
</tr>
</thead>
<tbody>
<tr>
<td>No reaction</td>
<td>-</td>
</tr>
<tr>
<td>1+</td>
<td>+1:25</td>
</tr>
<tr>
<td>2+</td>
<td>+1:50</td>
</tr>
<tr>
<td>3+</td>
<td>+1:100</td>
</tr>
<tr>
<td>4+</td>
<td>+1:200</td>
</tr>
<tr>
<td></td>
<td>I 1:400 or higher</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>I 1:25</th>
<th>+1:25</th>
<th>I 1:50</th>
<th>+1:50</th>
<th>I 1:100</th>
<th>+1:100</th>
<th>I 1:200</th>
<th>+1:200</th>
<th>I 1:400 or higher</th>
</tr>
</thead>
<tbody>
<tr>
<td>No reaction</td>
<td>1</td>
<td>8</td>
<td>15</td>
<td>21</td>
<td>8</td>
<td>8</td>
<td>2</td>
<td>(1)</td>
<td></td>
</tr>
<tr>
<td>1+</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2+</td>
<td>1 (1)</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
<td>(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3+</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5 (3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12 (11)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figures in parenthesis represent number of herds from which Brucella was isolated.
### Table III

*Relationship of Milk Whey Agglutinin Titers to Blood Serum Agglutinin Titers and Isolations of Brucella from Both Vaccinated and Nonvaccinated Cows*

<table>
<thead>
<tr>
<th>Blood Serum Agglutinin Titers</th>
<th>Whey Agglutinin Titers</th>
<th>Total Serum Titers</th>
<th>Total Isolations</th>
<th>Per Cent Isolations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not tested</td>
<td>Negative</td>
<td>1:25</td>
<td>1:50</td>
</tr>
<tr>
<td>Negative</td>
<td>1</td>
<td>9</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>I 1:25</td>
<td>8</td>
<td>55</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>+1:25</td>
<td>4</td>
<td>52</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I 1:50</td>
<td>13</td>
<td>216 (1)</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>+1:50</td>
<td>10 (1)</td>
<td>81 (2)</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I 1:100</td>
<td>1</td>
<td>26 (1)</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>+1:100</td>
<td>10 (1)</td>
<td>16 (3)</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>I 1:200</td>
<td>1</td>
<td>10 (2)</td>
<td>3 (1)</td>
<td>3 (2)</td>
</tr>
<tr>
<td>+1:400 or higher</td>
<td>4 (2)</td>
<td>10 (2)</td>
<td>3 (1)</td>
<td>3 (2)</td>
</tr>
<tr>
<td>Total whey titers</td>
<td></td>
<td>557</td>
<td>20</td>
<td>28</td>
</tr>
<tr>
<td>Total isolations</td>
<td></td>
<td>59</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Per cent isolations</td>
<td></td>
<td>1.62</td>
<td>5.0</td>
<td>10.71</td>
</tr>
</tbody>
</table>

Figures in parenthesis = number of cows bacteriologically positive for Brucella.

Negative = no agglutination in 1:25 dilution.
SERO-AGGLUTININ TITERS AND UDDER INFECTION

Factors responsible for the inconsistent results were acidification of the milk, mastitis and early and late stages of lactation.

The results of studies conducted to show the relationship of milk whey agglutinin titers to blood serum agglutinin titers and isolations of Brucella from the milk of both vaccinated and nonvaccinated cows are shown on Table III. If whey agglutinin titers of $1:25$ or higher are considered indicative of infection, the whey agglutination test correctly identified $39$ or $81.25$ per cent of $48$ bacteriologically positive cattle and $548$ or $84.18$ per cent of $651$ bacteriologically negative cattle tested. In comparison, since blood serum agglutinin titers of $+1:100$ or higher are accepted as the established criterion of infection, $45$ or $93.75$ per cent of the same $48$ cattle were identified correctly by the sero-agglutination test. Both tests were in agreement on classifying $38$ of $48$ bacteriologically positive cows; however, they failed to properly identify one. Of the $10$ infected animals on which these tests results disagreed, the whey test correctly identified two cows that were classified as uninfected by the sero-agglutination test but failed to identify eight that were properly classified by that test.

DISCUSSION

The significance of using udder infection as a criterion of Brucellosis in cows is demonstrated by our findings that Brucella abortus was isolated from the udders and supramammary lymph glands of $93.5$ per cent of $92$ infected cows at the time of autopsy. Regardless of procedures employed for controlling brucellosis, none are absolutely perfect. This is also true with diagnostic tests, regardless of the titer level used for indicating infection. With any diagnostic level, there is always the possibility of not identifying some infected animals, however, this calculated risk should be similar in both nonvaccinated and calf-vaccinated cattle regardless of the levels selected.

The data presented strongly suggests that serious consideration must be given to liberalizing the interpretation of the sero-agglutination test on properly vaccinated cattle if discrimination against these animals is to be eliminated and calf-vaccination is to remain an integral part of the brucellosis control and eradication program. In addition, more emphasis must be placed on the brucellosis status of the herd if sound judgment is to be exercised in disposing of individuals with questionable titers and in recommending sound control procedure. All of the results of our studies fully support this philosophy, and is emphatically demonstrated by the fact that $98.04$ per cent of the virulent Brucella abortus isolations were from cattle in herds which harboured one or more animals with sero-agglutinin titers of $I:400$ or higher.

The percentage of demonstrable udder infection was two to four times greater in nonvaccinated than in vaccinated cattle in all titer levels between $I:50$ and $I:400$. If it is logical to accept the $+1:100$ titer as the diagnostic level of infection in nonvaccinated cattle, it is just as logical to accept the $+1:200$ titer as the diagnostic level of infection in officially calf-vaccinated cattle since these are the points where the infection rates rise sharply. This would mean that the diagnostic titer would be one dilution higher in vaccinated than in nonvaccinated cattle.

A comparison of present and alternate interpretations of the sero-agglutination test is presented in Table IV.
### TABLE IV
Interpretations of the Sero-Agglutination Reactions in Calf-Vaccinated and Nonvaccinated Cattle

<table>
<thead>
<tr>
<th>Interpretations</th>
<th>Calf-Vaccinated Cattle</th>
<th>Nonvaccinated Cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Animals</td>
<td>Brucella isolations</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td><strong>Present</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactor—(+1:100 or higher)</td>
<td>27.63</td>
<td>176</td>
</tr>
<tr>
<td>Suspect—(I 1:50—I 1:100)</td>
<td>61.69</td>
<td>393</td>
</tr>
<tr>
<td>Negative—(+1:25 or lower)</td>
<td>10.68</td>
<td>68</td>
</tr>
<tr>
<td><strong>Alternate</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactor—(+1:200 or higher)</td>
<td>8.01</td>
<td>51</td>
</tr>
<tr>
<td>Suspect—(I 1:100—I 1:200)</td>
<td>36.73</td>
<td>234</td>
</tr>
<tr>
<td>Negative—(+1:50 or lower)</td>
<td>55.26</td>
<td>352</td>
</tr>
</tbody>
</table>

The infection rates in the three classifications of calf-vaccinated animals (reactor, suspect, negative) as determined by the alternate interpretation of the sero-agglutination test were almost identical to those in the same classifications of nonvaccinated animals as determined by the present interpretation. Consequently the risk of retaining infected cattle in herds is no greater in the calf-vaccinated animals than in the nonvaccinated animals. The significance of this is substantiated by the fact that the percentages of calf-vaccinated and nonvaccinated cattle which originated in infected herds were practically the same. In addition, use of the alternate interpretation of the sero-agglutination test to classify vaccinated cattle, reduced the numbers of reactors and suspects approximately 300 per cent and 40 per cent respectively and increased the number of negative animals approximately 500 per cent.

The greatest benefits derived from use of the alternate interpretation of the sero-agglutination test will be realized only when calves are vaccinated at the proper age, i.e. 6 to 8 months. This can best be demonstrated by presenting unpublished data on the recedence of vaccinal titers in 88 heifers vaccinated at eight months of age and 73 heifers vaccinated at 12 to 15 months of age. Vaccinal titers of 95.46 per cent of the animals vaccinated at eight months of age had receded below the I 1:100 level by the time they had reached 30 months of age; whereas, the titers of only 43.83 per cent of the animals vaccinated as yearlings had receded below the same level at the same age. Similar information on the relationship of vaccination...
SERO-AGGLUTININ TITERS AND UDDER INFECTION

The role of calf-vaccination as an aid in controlling brucellosis can best be demonstrated in Jersey County, Illinois. After completion of an informative blood serum agglutination test on cattle in this area calf-vaccination was initiated on a rather large scale in 1942 and continued for at least the next 10 years. Elimination of infected cattle was done principally by disposing of them when they became unprofitable. Two subsequent, informative blood tests were conducted in the county at five year intervals. Reduction of the infection rate was discouraging at the end of the first five-year period but was rather spectacular at the end of the second five-year period. This is best demonstrated by giving the percentage of reactors found on the following tests: 5.018 per cent in 1942, 3.7 per cent in 1947 and 0.53 per cent in 1952.

In New York where 12 of the 13 atypical strains of Brucella abortus were isolated, there was no evidence that strain 19 vaccine was less effective against these variants than against typical strains of Brucella abortus. In the great majority of vaccinated herds where infection was found, there were histories of purchasing replacement animals. Even in these herds the disease was benign in character.

The relatively low sero-agglutinin titters found in adult cattle properly vaccinated as calves with strain 19 does not appear to materially affect the efficiency of the milk ring test as it is now applied in the field. Therefore, the test remains an effective diagnostic aid in the control of bovine brucellosis. This was ably demonstrated by the findings that it correctly classified 94.12 per cent of the bacteriologically positive and 78.5 per cent of the bacteriologically negative herds. Furthermore, the milk ring test also classified the most potentially dangerous herds, which contain cattle with titers of $I_{1}:400$ or higher, as infected.

The whey agglutination test is also of value in diagnosing udder infection in the individual animal but is difficult to apply in the field. In addition, conditions such as mastitis and stages of lactation interfere considerably with the accuracy of the test on quarter milk samples. When comparative tests were conducted, the percentage of accuracy in correctly classifying cattle was greater with the sero-agglutination than with the whey agglutination test.

SUMMARY

Milk and blood samples were collected from 637 vaccinated and 103 nonvaccinated cattle for bacteriological and serological studies. The samples were obtained from 477 cows in New York State and 263 cows in Jersey County, Illinois.

Udder infection was demonstrated in 51 of the cattle studied. Thirty-eight of the Brucella abortus isolations were typical in all respects. Of the 13 atypical strains, 12 were isolated from cattle in New York State.

Brucella was isolated from the milk of 4.55 per cent of the calf-vaccinated cattle and from 21.35 per cent of the nonvaccinated cattle. The percentage of infection in vaccinated cattle at the various titer levels was approximately the same in all age groups.

The percentage of Brucella isolations was two to four times greater in the nonvaccinated than in the vaccinated cattle at each sero-agglutinin titer level except...
for those animals with titers of $1:400$ or higher where the percentage was approximately the same. The most precipitous rise in percentage of infection began with the $1:100$ titer in nonvaccinated and $1:200$ titer in vaccinated cattle. Consequently, the diagnostic sero-agglutinin titer level was found to be one dilution higher for vaccinated than for nonvaccinated cattle if the present interpretation of this test is used as the standard.

Of all the isolations made from both vaccinated and nonvaccinated cattle, 98.04 per cent were from cows within herds which contained one or more animals with sero-agglutinin titers of $1:400$ or higher.

No isolations of *Brucella abortus* were made from the milk of vaccinated cows with sero-agglutinin titers in dilutions below $1:100$.

The milk ring test conducted on herds practicing vaccination correctly identified 94.12 per cent of those that were bacteriologically positive and 78.5 per cent of those that were bacteriologically negative.

When whey agglutinin titers of $1:25$ or higher are considered indicative of infection, the whey agglutination test correctly identified 39 or 81.25 per cent of 48 bacteriologically positive cattle and 548 or 84.18 per cent of 651 bacteriologically negative cattle.

An alternate interpretation of the sero-agglutination test for brucellosis in classifying calf-vaccinated cattle has been discussed. The efficiency of this alternate interpretation in classifying calf-vaccinated cattle is nearly identical to that of the present interpretation in classifying nonvaccinated cattle.

The authors gratefully acknowledge the assistance of the following persons: Drs. R. W. Carter and M. J. Kemen, Jr., Disease Eradication and Control Branch (A.R.S.) who collected milk and blood samples in Illinois and New York respectively, and made possible the arrival of samples in satisfactory condition at the Animal Disease Station. Dr. E. L. Love and Mr. Herbert L. Keech who conducted serological examinations of the blood and milk samples.

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CONTROL AND ERADICATION OF BRUCELLOSIS IN A RANGE STATE

F. S. Brenner

Grant, Montana

The subject of this talk is the control and eradication of brucellosis in a range state. I feel that the only way that a layman can approach such a subject is to summarize twenty-five years of experience with brucellosis.

First to set the scene. My outfit is in what you call a semi-range area of Montana at an elevation of from 6000 ft. to as high as a cow wants to go. That means a long winter feeding period in comparatively confined areas—300 to 600 acres to a bunch of cattle, or roughly one cow per acre for winter feeding plus fall and spring grazing on the hay stubble. These cattle are fed by scattering loose hay from a wagon or sled on the meadows, so most of the time the feed ground is changed every few days as the hay stacks are used up. However, there is a lot of crowding of cattle during the winter, and a good opportunity for the spread of infection. That condition is somewhat mitigated by a lot of extremely cold, clear weather.

In the summer months—mid May to October—the cattle are on high mountain range, deeded, Taylor grazing, or Forest, as the case may be, and usually mixed to some extent with cattle of other owners. The concentrations will vary with the range from one cow to ten acres on up, depending on conditions.

Our calving period is March to May in the main, and mostly we calve in the hay fields with only willow brush for shelter. We ride those fields steadily and do a lot of work, but even then a cow is mostly on her own.

Now—my first experience with brucellosis was twenty-five years ago this coming spring. We got modern and progressive and tried locking a couple of hundred first calf heifers up in a forty acre lot for calving; the object—to save on riding and keep a close watch. We even built a cabin there so a man could stay with them. I was riding the cow bunch, and on the first day of April after I had made my morning ride went up to see how the heifers were doing. “How is it going?” says I. “Not so good,” says he. “Sixty-six dead ones and thirty-three live ones.” With a range man’s instinct—and don’t discount that—I rode over and opened the gate. “Give them room”, I said. Then I headed for town.

Well, the Vet said “Bangs”, and he wanted to test some, and I headed for home to battle with the elders of our livestock company. Home to hear the arguments that we still hear in some circles about mouldy hay, and slipping on the ice, and pine needles, and so on. But I toughed it out and got the heifers tested—twenty-seven of them that had come back into the lot to bawl at their dead calves. We got twenty-eight reactors, because the Vet insisted on testing our blue ribbon Jersey milk cow and she had it too. Then I was in the dog house.

So what do we do now? And the Vet talked about test and slaughter, and segregation, and disinfecting the premises (roughly three thousand acres of calving area) and probably a few other things that were all as practical as pockets in your underwear. Consider that at that time we opened the gates about May first and sicked the dogs on them. I carried at least fifty brands in my head that our cattle
mixed with, and they scattered for a hundred miles in two states. All we could do ride and learn, and Brother, you learn a lot on a forty-five per cent calf crop. We learned to keep them scattered as much as possible at calving time. We learned to sell all our dry cows because so many were barren anyway. We learned that you can’t operate on a forty-five per cent calf crop. And also we learned some little things that aren’t in the books—like for instance, if a Hereford calf bawls before he gets up and sucks you might as well ride off and leave him. The chances are that he is premature and won’t make it, no matter how hard you work on him.

So we kept riding and trying and hoping and learning, and we got some built up resistance, and we hung on, and by the mid-thirties we began to hear a rumor of some vaccine, but it did us no good, because our regulations said that we could not import the live virus. (I have heard since that a little judicious bootlegging helped bail some of the boys out, and they even made a profit dealing with some trusted neighbors.)

Then came 1938 and the man said “GO”. We were one of the first outfits in Montana to use Strain 19 under a Federal experimental program. We never tried adult vaccination, but within a couple of years we started operating again instead of just hanging on. We can figure an eighty to ninety per cent calf crop even with deep snow and thirty below zero calving weather. We can cull a lot of yearling heifers now, and old wet cows, and improve our herds instead of just hanging on for any kind of calves.

That is one man’s story. Now let’s take it to the county level. My county is quite a county, and I’m proud of it. We have over three and a half million acres—an area roughly one hundred and fifty miles long lying along the continental divide. About forty per cent of the land is privately-owned and there are about four hundred cattle owners in the county, ranging from some ten thousand head outfits down to three-cow diversified farmers. The cattle in the county total about ninety one thousand head. It is mostly a cattle country and we make our living strictly on cattle. That has a bearing on the case, as do the figures, so I will ask you to remember them.

Now to go back to when Strain 19 vaccine became available. That is the time when our Vet, a new one, bless him, got busy. He sold vaccine everywhere in the county to everyone who would go for it—and here is what made the difference. He sold it and did the work of vaccinating for fifty cents a head. Not much profit, but a lot of work, and it did the job. In other areas the vets saw a chance for some easy money and charged a dollar or more. They made a little, but the cowmen balked—and the community lost by it.

We vaccinated and prospered, and it never occurred to us that other areas were not doing the same. We had a few hard-heads of course. They are everywhere. I had an old French-Canadian neighbor and I loved him like a father. He ran about thirty five cows and got about five to seven calves a year. But “Is no tabushin is som’pin else.” and he fed yellow salt, and pink salt, and red white and blue salt and even inoculated with old frozen blackleg vaccine, and got no calves. To the day he died it was “som’pin else” and it is a good thing he did not need much to live on. Unfortunately there were a few bigger operators who were not any smarter.
CONTROL AND ERADICATION OF BRUCELLOSIS

Last year our State Sanitary Board decided to try to clean up the state. Our county signed up as a Brucellosis Control Area and started testing about October 15. In less than eight months the whole county had been tested once. Now we did not have to test all of the cattle. In the herds that had a history of official vaccination for at least three years it was decided that 20 per cent of cows over three would give a good check and it worked.

Here are some of the results of the first test. Of the four hundred herds in the county, seventy were found to contain reactors. Not so good—but—out of the 91,000 head there were only 438 reactors. That is better. 138 of the reactors were in one herd. That is better yet. Remember one reactor on a ranch makes a reactor herd, and we found places where a big outfit had bought a milk cow—maybe from out of the state. She reacted and we had a big reactor herd without a single range cow being infected. There were really only about three or four badly infected herds and less than two per cent of the cattle in the county. Now, a year later, forty of the seventy herds have been retested and found clean. There are thirty herds left to retest and within thirty days we will find that Beaverhead County, Montana is a certified modified brucellosis-free area.

Proving what? Proving to my satisfaction and to that of our good veterinarian that vaccination can clean up brucellosis in a range or semirange area. Without our past history of vaccination neither of us would have lived long enough to see our county cleaned up and certified.

But it is not quite as easy as this looks either. Remember that Beaverhead County is cattle country and it is full of good cowmen. Cattle are our living and our way of life. We have the equipment and we know what to do. Round up and blood test one hundred cows? Sure. Nothing to it. It is a short and easy job with good horses, experienced men, good corrals, good chutes—and owner co-operation. That last point is important. There is nothing in our law that says a man has to get rid of reactors. He can string along with them under a “quarantine”, or as some of us prefer to call it, a restricted herd basis, and if he will vaccinate regularly and carefully he has a chance of wearing it out of his herd in time. Our living comes from our calf crop, and we know it, so the usual course of events runs something like this: “What? Old Twinkletoes a banger? I don’t believe it.” Then, “She’s a good cow and I’m going to keep her. She always brings in a good calf.” Then after a couple of months of riding by that “B” on the jaw and that reactor tag, there is a kind of muttering that sounds like, “Eating good feed and ruining my reputation as a cowman”, and pretty soon after that “Old Twinkletoes” boards a slatted car for her date with destiny.

This is cow country, but we have a lot of conditions in a state as big as Montana. There are a lot of areas where cattle are a sideline to grain or beets or sheep. That is where lack of facilities, and lack of knowledge, and lack of interest can make brucellosis cleanup a long, slow, laborious process. There are areas where speculation, and trading, and “in and out” operations are more the rule than steady, year in and year out, raise them, grow them and sell them business. Some of these “make your dollar and get out” boys object to a little restriction and a little added expense. There are areas where we have big year around grazing operations. The cattle aren’t concentrated so closely and there is not much chance of a violent
"storm of abortion". Some of those boys would rather drift along losing their shirts button by button than jump out and clean up brucellosis under a state wide program. And everywhere, you have a few ranchers who don't know what they have got and are afraid to find out. Remember that cowmen are still pretty rugged individualists and resent even the appearance of being told what to do.

So we have our troubles. Montana is progressing well in its campaign to clean up brucellosis but there is still a long, hard trail to ride. Four years ago there was a need and a demand to clean up Lake County which contains a lot of dairying, so the Livestock Sanitary Board asked for twenty thousand dollars in its appropriation. For political reasons that a lot of you gentlemen can understand, I, as a member of the Committee on Appropriations pulled the request out of the general appropriation and introduced it as a special bill which could be defended as a public health measure as well as a livestock measure. That worked and helped set the pattern for a state wide program. Two years ago next January there was discussion with the Legislature of a state wide program but there is always a matter of funds. However, the Sanitary Board found that by the use of some emergency funds and with substantial help from the Federal Government, the program could be started.

Funds have always been my big worry in this job. Montana just can not put up enough money out of the state General Fund to finance our program. We are kind of long on cows and short on taxpayers. However, the special brucellosis appropriation of the last Congress is going to give us a big boost. We can really roll in the next couple of years. We are all set up and ready to make the most efficient use of the Federal money. We expect to be able to carry out the job, even to the extent of vaccinating all of the heifer calves in the state as fast as they are signed up in control areas.

Our law says that it takes petition by seventy-five per cent of the owners with at least fifty per cent of the cattle to form a disease control area. It would be fairly easy to get a county here and a county there to petition for help right off the bat. But a hit or miss operation would have defeated a lot of good ends because it would have called for a lot of inter-county quarantines and a lot of inconvenience. So we started next to brucellosis-free areas in Idaho, and next to brucellosis-free areas in North Dakota. We went from there. The Extension Service did a big job in education and in circulating petitions. The area is mostly similar to my own—and the program went well. So far about two hundred sixty thousand head tested in about ten thousand herds. Less than two per cent reactors and less than twenty per cent reactor herds on the first test. The cost? About three hundred thirty thousand dollars all told.

Now you can see what we have tried to do. Push it this way and push it that way and keep our areas joined and growing. We have done the job in a lot of the areas where the need was the greatest and the most recognized. But now we are crowding toward the areas where there is lots of open range—where the disease has never reached extremely severe proportions and where the need of our program is not so clearly recognized. There is not so much interest nor is there such a clear understanding of the program.

Comes now the big item of education. Until all of the cattlemen understand fully
we are going to have some slow going. The Extension Service does a lot, but they are some of the hardest worked people in the United States and they can't do it all. We have recently formed a State Advisory Committee on Brucellosis to help with the job. It is composed of four cattlemen, one dairyman, one veterinarian, one public health man, one Extension Service man, and one from the livestock markets. I had both the misfortune and the honor to be made chairman of this committee. It is our hope to help guide the brucellosis program in the state and to help educate the areas where our program is not yet started. So far, our main accomplishment has been a unanimous request that no brucellosis money, either State or Federal, be used in Montana to pay indemnities on condemned animals.

Now for an idea or two for you to chew on. One—I think that calfhood vaccination can do even more good than it gets credit for. Two—physical conditions in many areas such as mine make vaccination at four to eight months of age extremely impractical. I find that vaccination up to fourteen months, where the heifers are segregated from sources of infection up until then, does just as well, and helps to encourage the wider use of vaccine. I'm all for anything that will help get the job done.

And we can do it. We can practically and finally eradicate *Brucella abortus* in Montana and in the whole United States but it is going to take a lot of education, a lot of patience, a lot of mutual understanding, and a lot of experience, gained the hard way as we go along. Let's have at it.
REPORT ON COOPERATIVE BRUCELLOSIS ERADICATION PROGRAM

A. K. KUTTLE, D.V.M.¹

More progress has been made in the fight against brucellosis during the past year than for any similar period during the 20-year-old nation-wide campaign to eliminate this costly disease from our domestic animals. When we take into consideration the obstacles encountered during this period including a poor start because the project was begun largely as a cattle reduction program, a tendency for brucellosis to lend itself to confusion, the most devastating war in history, and more emergency animal diseases than for any similar period, we need not make apologies for the progress made. We have been able to adjust ourselves to rapidly changing conditions which is one of the essentials to success in a continually changing world. When the project was begun we were plagued with surpluses. No sooner had we set up the test and slaughter program which was working better than many realize, than we were confronted with shortages of all kinds as a result of the war. A very rapid increase in prices resulted in a tendency on the part of owners to retain reactors to meet the growing demand for increased production. Fortunately we were ready with a substitute to the test and slaughter program—calf vaccination, and in some instances adult vaccination. The test and slaughter program became unpopular with large segments of the industry due to the necessity for frequent tests of infected herds where this method was adopted. Calf vaccination has placed us in the favorable position of having a high percentage of animals which are now resistant to Brucella infection. We are now in the best position ever to search out the remaining infected animals which have been reduced to the lowest level since the project was begun.

I was impressed with a letter from one State recently. The statement was made that the brucellosis problem had been considered and due to drought and other problems confronting the industry at this time, it was believed impossible to obtain State funds for expanding the brucellosis eradication program. Thanks to the faith and vision of those who made an opportunity out of what would have been considered a calamity by those with less courage, we took advantage of our problem of surpluses to test for bovine tuberculosis. In 1935 18 years after the bovine tuberculosis eradication campaign was begun over 25 million cattle were tested; 66 per cent more than had been tested in any previous year. This put us over the hump so to speak. The following year showed a reduction of bovine tuberculosis of more than 53 per cent. The momentum gained enabled us to celebrate in 1940 the accreditation as modified tuberculosis free all counties in the United States. I have no doubt as a result of the expanded brucellosis eradication project that we shall be able to certify as brucellosis free a number of our largest livestock-producing States within the next few years. Additional funds made available by the 83rd Congress to supplement continually increasing appropriations made by the States will make it possible to reduce in the

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near future expenditures on this project, while at the same time we shall enjoy the economic and public health advantages which will accrue through completing this important animal disease eradication project.

THE AMERICAN VETERINARY MEDICAL ASSOCIATION

There are no limitations to the opportunities afforded the veterinary profession to contribute to the livestock industry which accounts for more than half of all agricultural income. However, we must adhere to the ideal of eliminating rather than living with communicable diseases of domestic animals. The livestock industry knows the value of animal disease eradication. I hope all of you will refer to your June 1951 issue of the Journal and read the editorial, "Brucellosis Eradication—A Challenge To Be Met." This editorial was prepared by Dr. C. D. Van Houweling, now Director of Regulatory Programs in the Agricultural Research Service. Practitioners have never failed in the past and will not fail in the final clean-up of brucellosis. I have often reflected on the unselfishness of those who are willing to eliminate a source of their income. It is this spirit of service that has made America great. The American Veterinary Medical Association has had an active brucellosis committee for the past several years. A great deal has been accomplished by the Chairman of that Committee, Dr. John F. McAuliff, a practitioner in Cortland, New York, who has successfully handled the brucellosis problem in his area for a number of years. Doctor McAuliff has contributed greatly to the uniformity of thinking among practitioners. He has participated in State association meetings where he has recommended procedures outlined in Uniform Methods and Rules of the Association. For years practicing veterinarians have requested a seat at the conference table when procedures for eradicating brucellosis have been under consideration. In a number of States, practitioners are taking care of the brucellosis work on a per herd per head basis. This enables them to take care of their regular practice with the least interference. When representatives of the State Veterinary Medical Association have been invited to participate in planning the program they have never failed in carrying out their part of the bargain, which is to perform the major role in service at the farm level. I do not mean to infer that I have altered my thinking with regard to rendering service to the livestock industry in those areas where veterinary service is for any reason not available. However, I do believe such areas are rapidly vanishing and that it may be possible to provide veterinary service for all areas. Certainly the veterinarian is the only one properly trained for the purpose.

EDUCATION

Education, legislation and appropriations are the keys in the order listed to the success of any animal disease eradication project. To accomplish most education in connection with brucellosis must be done at the farm or ranch level. A number of States have done a creditable job in this connection. In the State of Minnesota, Information Service, Institute of Agriculture, University of Minnesota has compiled educational procedures now being followed in that State. This information has been made available in booklet form to the director of extension in each of the States. If you have not already done so, I hope you will read this outline carefully, and pattern
your educational program after it if you do not have a better one. Reference is made in this booklet to stories and script for county agents, releases to the local and daily newspaper, material for radio and television stations, magazines, visual aids, etc. I am especially impressed with such statements in this material as follows:

"In most counties a county coordinated committee was active. Medical doctors, veterinarians, the county nurse, vocational agriculture instructors, livestock breeders, and others interested worked with extension agents or those committees and assisted at meetings and other campaign activities.

"Among those who helped the extension-planned educational program along in each community were newspaper editors and radio stations, doctors, health officers veterinarians, county nurses, vocational agriculture instructors, livestock breeders, cattle owners and others.

"Leading cattle owners become interested in having their county adopt the program. Working with their county agent, they set up a committee and adopt an educational program to acquaint cattle owners with the disease and the eradication program. When the program is sufficiently understood, petitions are circulated among all cattle owners."

The Information Division of Agricultural Research Service of the United States Department of Agriculture will assist the Animal Disease Eradication Branch, the United States Livestock Sanitary Association and the National Brucellosis Committee in preparing educational material to be used in accelerating the brucellosis eradication project. Speech notes prepared by the Division have been examined and approved by those who have been closely associated with brucellosis research and its application in the field. This material will be of assistance to those who do not have time to prepare information on all phases of the problem, and will serve to promote uniformity in the educational effort.

INTERSTATE REGULATIONS

You are familiar with the proposed interstate regulation pertaining to brucellosis recommended by the Association and representatives of member organizations of the National Brucellosis Committee. As you know this proposed regulation has finally been rewritten and was published in the Federal Register. I am sure some have been annoyed at the long delay. However, general acceptance, as a result of careful consideration being given to all objections raised this regulation as it is now written, will aid greatly in its enforcement. All of us are aware of the advantages which accrue to animal disease eradication projects when marketing restrictions are enforced with regard to movement of infected as well as exposed animals. Acceptance and support of these restrictions by major livestock producing groups is a tribute to their vision and willingness to supply the consuming public with what they want—an abundant and wholesome food supply of animal origin. This regulation can be a potent influence in completing the brucellosis eradication project, or it can be just another regulation, depending on how well it is enforced. In a number of the States highway patrol officers have assisted in enforcing State laws. The Federal regulation will give us additional support and encourage greater uniformity in regulations, thereby giving better service to the industry. The respect shown for laws and regulations by transportation companies after a period of enforcement has been marked.
BRUCELLOSIS ERADICATION PROGRAM

PUBLIC HEALTH

Immediately following the meeting of the National Brucellosis Committee last May, I sat in on a conference of State Livestock Sanitary officials, milk producers, processors, public health officials and others interested in the brucellosis problem in the Chicago milk shed. At no time during my many years of experience in animal disease eradication have I witnessed a more cooperative attitude and willingness on the part of all in attendance at this meeting to face the brucellosis problem unselfishly. Most of you are familiar with the outcome of this conference which culminated in the forwarding of a letter by the Public Health Service, Washington, D.C. to regional health directors of the Public Health Service which in effect accepts the milk ring test for herds wishing to qualify for grade A milk. This recognition provides that such herds must have passed at least three consecutive negative milk tests conducted under approved procedures at intervals of not less than four months nor more than six months provided that semi-annual milk tests are conducted thereafter. If any milk test indicates infection in the herd, blood tests will then be required as outlined in Uniform Methods and Procedures for blood testing until such time as the herd is brucellosis free. Then semi-annual milk tests may be resumed until such time as infection in the herd may be indicated by the milk test. The milk test will in my opinion be to brucellosis eradication what the intradermic tuberculin test was the tuberculosis eradication project. We all know the hopelessness of the situation in trying to tuberculin test all cattle in the country by the subcutaneous method. Blood testing of all cattle at sufficiently frequent intervals would pose a similar problem. A communication has also been sent to all regional offices of Public Health Service concerning the use of antigen for making the milk ring test. The necessity of close cooperation with the State and Federal Livestock Sanitary officials in each State was pointed out in this letter. Public Health officials have always been very helpful, especially where the disease in question may be transmitted from animals to man. As you know, the 1953 Milk Ordinance and Code had nothing to say about the milk test. However, Public Health officials have shown their willingness to go along with us in recognition of the milk test.

VACCINE

I am sure we should continue to expand the use of strain 19 until we have further reduced Brucella infection in the entire country. In the ranch areas systematic vaccination on an area basis will make it possible to eliminate Brucella infection with a minimum of testing as now provided for in the Uniform Methods and Rules. We should strengthen present procedures for identification of animals officially vaccinated and confine vaccine to calves except in emergencies. Provisions should also be made for disregarding titers in officially vaccinated animals which do not exceed complete agglutination in 1:200, provided that no other evidence of Brucella infection exists in the herd and, provided further that officially vaccinated animals which react in a titer of 1:200 should be confined to the premises and subjected to a test at not less than 30 days and classified as a reactor if the titer is stabilized or receding at complete in 1:100 in animals officially vaccinated as calves in herds showing no other evidence of infection. There is ample evidence to prove that when calves are vaccinated at from six to eight months it is rare for any of them to have a blood
agglutination titer in excess of $1:100$ at 30 months of age. It is recommended that
diagnostic titers for nonvaccinated animals remain as at present. It is significant
that in the Northeast where Brucella infection was relatively high when the project
was begun, and where a much higher percentage of calves have been vaccinated than
in other sections of the country, the percentage of brucellosis is now lower than in
any other region of the country. The percentage of cattle tested in northeastern
States is several times higher than in other areas.

Notice has been received that M vaccine is now being chemically killed and rec-
ommendations are that two injections be made, the second one four months
after the first.

THE NATIONAL BRUCELLOSIS COMMITTEE

The National Brucellosis Committee which is made up of representatives from
all organizations, which are in any way interested in livestock production, held its
best-attended meeting since its organization in Chicago May 13. The Chairman of
your Brucellosis Committee, Dr. R. W. Smith, attended this meeting. A copy of my
report, "A Review of the States’ Brucellosis Programs," made to the National Bru-
cellosis Committee has been furnished to all State and Federal cooperative officials.
The National Brucellosis Committee has continued to support all phases of the bru-
cellosis eradication project, especially in the field of education and has requested
slides which may be used at meetings attended by officers of this association.

We should review recommendations made by the association for brucellosis erad-
ication which have been made available to all of us since they were adopted in 1947
now referred to as "Uniform Methods and Rules for the Establishment and Main-
tenance of Certified Brucellosis-free Herds of Cattle and Modified Certified Areas."
Very few States have included and are enforcing all of these recommendations which
are considered a minimum. As you know regional brucellosis conferences have re-
cently been held in all parts of the country and the expanded brucellosis eradication
project is developing satisfactorily in all States.

Brucellosis eradication in swine and goats must not be disregarded. Leaders among
both goat and swine breeders are giving serious consideration to the problem along
lines recommended by the Association.

SUMMARY

If we have gained anything from our experience in animal disease eradication, it
is that to eradicate communicable disease of domestic animals it must be done on an
area basis. With our methods of movement and continual interchange of livestock,
the area should include the entire area involved which in this case is the entire United
States.

It will be possible as a result of the expanded brucellosis eradication project to
certify as brucellosis free a number of our largest livestock producing States during
the next two years, provided all groups concerned continue to work together, accept
and adhere to standards agreed upon by the majority based upon conditions exis-
ting in the herd or area involved.

We are out in the open. The ball has been passed to us by those who made policy
and provided funds for animal disease eradication. Let's make another touchdown
in our long and successful animal disease eradication work.
Mr. President and members of the U. S. Livestock Sanitary Association, your Committee on Brucellosis has met and we recommend changes in the Uniform Methods and Rules for the Establishment and Maintenance of Certified Brucellosis-free Herds of Cattle and Modified Certified Areas, unanimously adopted by the United States Livestock Sanitary Association, September 25, 1953. In our opinion these changes are fully justified as a result of recent research. We commend those who have done the often monotonous and routine labor usually associated with research. We trust that all will take advantage of the improved tools made available to us in our campaign to eradicate brucellosis in domestic animals. We express our deep appreciation to the 83rd Congress for making available additional funds to the Secretary of Agriculture for expanding the brucellosis eradication project. We request that the Secretary of this Association be instructed to express to the Chairman of the Committees of Agriculture of the House and Senate and to the Secretary of Agriculture our gratitude for their vision in this connection. We give them our promise to utilize funds made available for brucellosis eradication by both State and Federal governments to the best interests of the livestock industry.

Your Committee recommends that all interested groups in each of the States review carefully the recommendations for brucellosis eradication which were adopted by this Association December 4, 1947. These recommendations have been endorsed by nearly all interested groups including the American Farm Bureau Federation, the National Dairy Council, the American Purebred Dairy Cattle Association, the American National Cattlemen's Association, the National Brucellosis Committee and many other interested groups of State and National standing. Progress made in the different States is without exception in direct ratio with compliance to these recommendations.

We request the Animal Disease Eradication Branch of Agricultural Research Service of the U. S. Department of Agriculture to allot Federal funds made available for brucellosis eradication; First, to those States which have enacted laws and adopted regulations which provide for compliance with these recommendations. We encourage all States which are not now following procedures as outlined in these recommendations and uniform methods and rules to adopt them as soon as possible.

We confidently believe that the opportunity to achieve another milestone in the long march of animal disease eradication which has meant so much from the standpoint of an abundant and wholesome food supply of animal origin has been presented to us by the 83rd Congress and those States which have continued to improve their programs for brucellosis eradication.

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These accomplishments could not have been made without the leadership and service of practicing veterinarians working at the farm and ranch level and acceptance of the ideal of eliminating, rather than living with, animal disease by producers in this choice land which has set an example to a troubled world of directing our energies to the elimination of those forces which would destroy or contaminate our food.

In the years that have followed since 1947, changes have been made in the recommendations for brucellosis eradication as conditions warranted. Each year, as our research people bring us new information, we are able to make adjustments which bring us nearer to our goal.

Therefore, this Committee recommends.

That wider use be made of, and further recognition be given to, the milk or cream ring test for brucellosis control to the extent that herds which have passed three successive negative tests at not less than four months nor more than six months, be classified as Grade A herds and that such herds be continued in that status upon semiannual negative tests. This test makes it possible to locate more promptly and economically brucellosis infected herds than any other test now at our disposal. When properly used the milk test will aid us in eradicating brucellosis in dairy herds.

II

On the basis of recent research, this Committee recommends that animals officially vacinate as calves and properly identified shall be classified as follows: a negative is one that shows less than a complete agglutination reaction in the 1:100 dilution; a suspect is one that shows a reaction of not more than incomplete in the 1:200 dilution; and a reactor is one that shows a complete reaction in the 1:200 dilution or higher:

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<td>+ I</td>
<td>Reactor</td>
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and for nonvacinated animals, the interpretation of the blood serum agglutination test shall remain unchanged; that is a negative is one that shows less than a complete agglutination reaction in the 1:50 dilution; a suspect is one that shows a reaction of not more than incomplete in the 1:100 dilution, and a reactor is one that shows a complete reaction in the 1:100 dilution or higher.

This means that a tolerance of one whole dilution is granted when interpreting the results of the sero-agglutination test for establishing the brucellosis status of officially vaccinated animals.
If the recommendations of this Committee are approved, we further recommend that copies of the manuscript, "Relationship of Sero-Agglutination Titers to Udder Infection in Strain 19 Vaccinated Cattle," by Edwin R. Goode, Jr., T. E. Amerault, and C. A. Manthei be prepared for distribution to all State and Federal disease control officials as well as other persons or organizations associated with the control of bovine brucellosis.

It long has been recognized that the viability of Brucella abortus strain 19 vaccine is decreased considerably when subject to adverse environmental conditions. This is true for the dried as well as the liquid product but to a lesser degree. Therefore, this Committee recommends that the instructions for handling both the liquid and dried products be strictly adhered to. It is further recommended that calves be vaccinated with the full 5 cc. dose to insure the injection of adequate numbers of living strain 19 organisms necessary for the production of a serviceable protection against brucellosis.

III

We recommend that all States adopt Plan "A" as rapidly as possible and that we accept the proposition that when we reach our goal of brucellosis eradication, it will be on the basis of finally eliminating for slaughter the last infected animal.

IV

We request the Agricultural Research Service, U. S. Department of Agriculture to make the following changes in regulations dealing with brucellosis:

1. Indemnity payments for officially calf vaccinated reactor animals shall be made in conformity with the revised interpretation of the blood serum agglutination test as approved by the U. S. Livestock Sanitary Association.

2. All interstate shipments of Brucella vaccine, Brucella antigens, and other Brucella biologics used be reported by the distributor to State and Federal cooperating livestock sanitary officials of the State of destination.

We request that these recommendations be accepted and be written into the Uniform Methods and Rules for the Establishment and Maintenance of Certified Brucellosis-free Herds of Cattle and Modified Certified Areas, unanimously adopted by the U. S. Livestock Sanitary Association, September 25, 1953.

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REPORT OF SWINE BRUCELLOSIS COMMITTEE

J. R. HAY, Columbus, Ohio, Chairman; H. U. GARRETT, Des Moines, Iowa; A. B. HOERLINE, Ames, Iowa; C. A. MANTHEI, Beltsville, Maryland; L. A. ROSNER, Jefferson City, Missouri; E. R. SHANNON, Lafayette, Indiana.

The Committee believes that Swine Brucellosis is a disease entity which can be controlled if proper rules and methods are adopted. There are states which have had five years' experience in the control of this disease.

In 1949, at the 53rd Annual Meeting of the United States Livestock Sanitary Association in conjunction with the report of the Committee on Brucellosis, a report was offered covering the control of Swine Brucellosis and the certification of swine herds as being Brucellosis-free. At the time of this report, only two states could report a program in effect. In 1954, information collected by the return of a questionnaire from 48 states and the Territory of Hawaii shows that 13 states now have a definite program in operation.

The 1954 survey of states indicates that Alabama, California, Idaho, Illinois, Indiana, Iowa, Maryland, Minnesota, Mississippi, New Jersey, North Carolina, Ohio and Wisconsin have testing programs and herd certification programs. Of these 13 states, 12 certify for a period of one year, while Maryland certifies for six months. In 11 states, two herd tests are required for certification, while Alabama and Idaho require three tests. Blood testing ages show great variation. Idaho and Wisconsin test at weaning age—California, Illinois and Maryland at breeding age—Alabama and Ohio at three months of age—North Carolina at four months of age—Indiana, Iowa, Minnesota and Mississippi at six months of age, while New Jersey does not specify any exact age. Eight states have regulations requiring the testing of swine for exhibition (Alabama, California, Idaho, Illinois, Indiana, Maryland, Minnesota and Ohio), while eight states have importation requirements (Alabama, Idaho, Illinois, Maryland, Minnesota, Mississippi, New Jersey, North Carolina).

This Committee offers and recommends the following for adoption in the control of Swine Brucellosis:

A. Certification of Swine Herds as Brucellosis-Free

Certification is made on the basis of two negative tests on the entire herd thirty to ninety days apart. This includes all animals six months of age and over with no agglutination tests being positive 1:100 or higher. This certification is valid for twelve months. Recertification is made annually by the passing of a single negative test on the entire herd.

B. Plans of Control for Infected Herds

Plan 1. This is recommended for commercial herds.

1. Market the entire herd of swine for slaughter.
2. Clean and disinfect houses and equipment. Rest hog lots if possible.
3. Replace with stock from certified brucellosis-free herds, preferably placing them on clean ground for as long as possible.
4. Following two consecutive negative tests thirty to ninety days apart, the herd is eligible for certification.

**Plan 2.** This plan is recommended for use in purebred herds where it is desirable to retain valuable blood lines.

1. Separate pigs from sows at 56 days of age or younger and isolate as completely as possible.
2. Market infected herd as soon as practicable. If sows are held for later litters, complete isolation is essential. The disease has a greater tendency to spread as swine approach sexual maturity.
3. Test the gilts to be used for the following breeding season about thirty days before breeding. Save only those gilts which are negative. Breed only to negative boars.
4. Retest the gilts after farrowing and before removing them from individual farrowing pens. Should reactors be found, they should be segregated as far as possible from the remainder of the herd.
5. If herd is not clean at this time, the process is repeated another year. As soon as the entire herd can pass two negative tests between thirty and ninety days apart, it becomes eligible for certification.

**Plan 3.** This plan is not recommended in general but has been found useful in small herds where only a few reactors are found and where no clinical symptoms of brucellosis have been noted.

1. Remove reactors from farm.
2. Retest herd at 30-day intervals, removing reactors, until entire herd is negative.
3. Two clean tests, between thirty and ninety days apart, qualifies the herd for certification.
4. If the herd is not readily freed of infection, abandon this plan in favor of Plan 1 or Plan 2.

### C. Accessory Regulations

1. Blood samples are to be taken by an approved accredited Veterinarian.
2. Reacting animals must be sold for immediate slaughter.
3. Replacement swine may be added without test if procured directly from a certified brucellosis-free herd.
4. All other replacement breeding animals shall have passed a negative agglutination test and be held in isolation until passing a second negative agglutination test. The second test shall be at least thirty days after the first, in the case of boars and open gilts, or after farrowing in the case of bred sows and gilts.
5. All swine brought on to the farm for feeding purposes shall be segregated from the breeding herd until moved for slaughter.

The Committee further recommends that:

1. The present recommendation of the United States Livestock Sanitary Asso-
cation for certification periods be increased from the present period of six months to a period of certification for one year.

2. It is further recommended that all states adopt requirements for exhibition and the interstate movement of breeding swine as a step in the control of swine brucellosis.
THE PRESENT STATUS OF BOVINE-TYPE HUMAN TUBERCULOSIS IN THE UNITED STATES

JAMES H. STEELE, D.V.M., M.P.H.*

It is estimated that there are 1,200,000 cases of tuberculosis in the United States, 400,000 of which are active, and 800,000 inactive—but under medical supervision. The annual number of deaths from tuberculosis in this country and abroad has declined at an accelerated rate in recent years (Table 1). The case rate, however, does not show a corresponding rate of decline. Over 100,000 cases (Table 1) have been reported annually in the United States for the past 14 years. Although case-finding is now more extensive than in the early 1940's, and reporting is now more nearly complete, the evidence indicates that there are fewer new cases of tuberculosis occurring now than then. This decline, however, appears to be rather small in comparison with the drop of more than 65 per cent in the number of tuberculosis deaths in this same period. The dramatic drop in tuberculosis deaths is to a large extent a tribute to the improved medical and surgical care of tuberculous patients.

The available data do not reveal the type of tuberculosis except to separate pulmonary from other forms of the disease. In the past this separation has led to confusion, when it was assumed that most non-pulmonary tuberculosis was due to *Mycobacterium tuberculosis*, variety bovis. It is well to emphasize at this point that not all pulmonary tuberculosis is caused by the human type of *Mycobacterium tuberculosis*, nor is most extrapulmonary tuberculosis due to the bovine type. According to the results of a recent inquiry by the Public Health Service tuberculosis specialists, bovine type tuberculosis is a very rare human disease in the United States.

Before discussing the few cases which have been reported in recent years it may be well to review briefly the epidemiology of bovine-type tuberculosis in man.

**EPIDEMIOLOGY**

Extrapulmonary tuberculosis of man is often caused by tubercle bacilli of the bovine type. These infections are more frequent in children than in adults and are attributed to the ingestion of contaminated cows' milk. The extrapulmonary infections usually involve the cervical lymph nodes, tonsils, and abdominal organs. Formerly bovine tubercle bacilli were commonly found in infections of the bones and joints, skin, and in tuberculous meningitis. Outside of the United States the bovine organisms remain a frequent cause of such infections. All of the above forms of tuberculosis are caused more often by the human-type bacilli except the infections of the neck lymph nodes (Scrofula) in which the bovine type appears to be the prime cause. During the past 25 years these forms of bovine tuberculosis in man have become quite rare.

The pulmonary form of bovine infection in man, until a few years ago, was thought to be extremely rare but in recent years it has become evident that bovine-type phthisis is more common than previously supposed. Griffith (1) in England

and Sigurdsson (2) in Denmark, in studies before the war, when bovine tuberculosis was more prevalent, have shown that from one to six per cent of human pulmonary infections are caused by the bovine-type organisms.

Sigurdsson in his studies of the risk of infection with bovine tuberculosis in the rural population, with special reference to pulmonary tuberculosis, typed 566 cases of pulmonary tuberculosis and pleurisy, 165 of which came from rural areas. No fewer than 67 (40 per cent) of the 165 were infected with the bovine-type tubercle bacillus, whereas only 14 (3.6 per cent) of the urban patients had this type of infection. The epidemiological investigations of the rural cases revealed that 94 per cent of the patients with bovine-type phthisis had been in contact with "strongly infectious" cattle within the previous two years. There was a higher number of infections among males than females in the cases studied. The investigators also reported finding living bovine tubercle bacilli in the dust and dirt of the stables.

Hedvall and Magnusson (3) stated that previous to 1941 in southern Sweden about three per cent of the human pulmonary tuberculosis was of the bovine type. They also pointed out that bovine infection can be spread from man to animals with serious consequences. In one herd of 74 animals that they cite, 49 suddenly became reactors, the cause being a milker suffering from open bovine-type tuberculosis. Other investigators have reported similar observations and state also that bovine-type phthisis can be transmitted from man to man.

Griffith and Munro (4) in 1944 stated that the proportional frequency of human pulmonary tuberculosis due to bovine infections in Scotland and England, are: Orkney Islands 25.8 per cent; rural districts of northeast Scotland 9.1 per cent; remainder of Scotland 5.2 per cent; Alberdien, Scotland, 4.4 per cent; northern England 2 per cent; and southern England 0.6 per cent.

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<th>Year</th>
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<td>102,984</td>
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<tr>
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<td>105,567</td>
<td>59,251</td>
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<td>1942</td>
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<td>1953</td>
<td>106,925</td>
<td>19,870*</td>
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* Based on a 10 per cent sample.
The results of these surveys lead McDougall (5) to the conclusion that bovine-type bacilli are able to infect man not only through the digestive tract but also through the respiratory tract, and that a barn in which tuberculous cows are kept confined undoubtedly involves the same risk of infection as does the home of a tuberculous family. There is no reason to doubt that open bovine lesions are just as infectious as open lesions due to human-type organisms.

These observations raise a very important question for public health authorities in areas with a high rate of infection among cattle. If, as has been previously assumed, human bovine tuberculosis has been primarily a question of milk infection, its prevention would be comparatively easy, by requiring that all milk and milk products be pasteurized. But if inhalation infection is also to be considered as an occupational or environmental disease, the control of bovine tuberculosis is a far more serious problem which requires the elimination of all tuberculous cattle.

BOVINE-TYPE HUMAN TUBERCULOSIS IN THE UNITED STATES

Bovine-type infections in man, as previously stated, are exceedingly rare in the United States according to the reports received by the United States Public Health Service. In recent years the most important outbreak in the United States occurred in Ohio in 1948 (6). This outbreak came to the attention of the health authorities following receipt of a report from the State veterinarian stating that an infected herd had been found. This herd of 31 cows had 27 reactors to the tuberculin skin test. The previous year when these animals were tested, no reactors were identified. The infected animals were slaughtered and examination revealed tuberculous lesions in many of the animals.

The subsequent investigation by the health department tuberculosis specialist revealed that more than 200 families in the community received raw milk from this herd as well as other herds. The local school also received milk from the infected herd. The school authorities stated that the raw milk was used for cooking only. A skin patch test of 119 school children revealed 66 positive reactors. Of this group 35 had records of positive reactions or no test when tested 2 years previously.

The investigator also reported that a number of children had enlarged cervical lymph nodes and a number had been surgically excised. In no instance were they able to culture \( M. \) tuberculosis, variety bovis, although the histopathological observations were similar to that of tuberculosis.

Since the Ohio outbreak all of the cases that have been called to the attention of the United States Public Health Service have been individual cases. These include a middle-aged Chicago housewife (1949) who had spent her childhood on a Midwestern farm, and a young Connecticut housewife (1951) who had never lived outside urban areas except for brief service in the Navy. Another case was reported in Maine in an elderly person who was hospitalized with cancer. One case of bovine-type phthisis was observed in New York (1950). West Virginia health authorities discovered two cases (1951 and 1954) one of which was in a young mother (7) and the other in an elderly woman. Both of these cases were the pulmonary type. The West Virginia State Hygienic Laboratory identified the organism as \( M. \) tuberculosis, var. bovis. The isolates from Chicago, Connecticut, Maine, and West Virginia
were confirmed by the Communicable Disease Center, United States Public Health Service, Atlanta, Georgia.

The history of the younger woman revealed that she was a native of Poland who came to America as a war bride in 1948. She had been imprisoned in Germany from 1942-45. During this period she and other prisoners occasionally had access to a herd of cattle and raw milk was stolen as a survival measure. Following her release from prison, she had, according to her statement, not consumed raw milk in Europe or West Virginia. Regrettably the patient refused to remain hospitalized. In 1952 one of her children developed tuberculous meningitis and was hospitalized. Fortunately the child has made good progress.

The older woman who was found with bovine-type phthisis died. She had a history of occasionally using raw milk which was obtained from a dairy in a neighboring State. This woman worked as a waitress and had been X-rayed three years previously; no evidence of disease was observed at that time.

Michigan reported one case of cervical adenitis in a six year old boy this past summer (8). His home was on a farm where all of the cattle were found to be tuberculin positive when tested. The slaughter report on this herd revealed gross lesions in 15 of the 17 infected cattle. The Michigan Health Department investigated three other farms where tuberculin reacting cattle had been identified. Fortunately no disease was discovered, but reactors to the skin patch test were found on two of the three farms. The former case discussed was the first case reported in a child since 1948.

We would be amiss to believe that the above cases constitute all of the bovine-type human tuberculosis infections in the United States, but it can be stated that the Public Health Service either through its tuberculosis specialists, tuberculosis laboratory, or its field staff, has made a determined effort to ascertain the status of bovine tuberculosis infections in man and has found it a rare disease. At this point it is suggested that whenever evidence of tuberculosis is found in animals that the local or State health authorities be made aware of the outbreak. In many instances this will assist in finding human cases or in resolving the epidemiology of the disease in man or animals. You are all familiar with the excellent work of Stenius (9), Magnusson (10), Tice (11), Plum (12), Francis (13), and Fourie (14) in which they demonstrated the transmission of both human and bovine tuberculosis from man to cattle. Fortunately the decline of open cases of human tuberculosis has reduced this probability, but we should consider this possibility when tuberculosis is found in cattle. The rarity of bovine tuberculosis in man in the United States is evident by the paucity of cases reported, but health authorities should not become complacent.

REFERENCES

BOVINE-TYPE HUMAN TUBERCULOSIS

6. Personal communication, John D. Porterfield, Commissioner, Ohio Health Dept., Columbus, Ohio.
STATUS OF FEDERAL-STATE COOPERATIVE TUBERCULOSIS ERADICATION

A. F. RANNEY

For more than 30 years the tuberculosis eradication program has been operated on the basis of testing cattle and removing the reactors for slaughter. We give ourselves credit for reducing the infection rate from about 5 per cent to 0.11 per cent. Those who have worked long and hard to bring about this reduction in infection can feel a justifiable pride in their accomplishment.

During the fiscal year ending June 30, 1954, 10,234,665 cattle were tested and 10,886 reactors were found. The number of cattle tested amounts to 10.8 per cent of the Nation's 94,677,000 cattle. This is the largest number of cattle tested in a single year since 1942.

We ought to feel rather proud of these figures and the accomplishments they represent. But the fact is that there has been no change for three years in the percentage of animals tested that have reacted to tuberculin tests.

Does this mean that we are standing still in the tuberculosis eradication program? Have we reached an irreducible minimum in the rate of infection? Certainly every member of this Association knows that you don't stand still in a disease eradication program until the disease is stamped out. We all know, too, that since 1940, when the last State was declared a modified accredited tuberculosis-free area, there has been a tendency to rest on our oars and let the assumption reach the public that tuberculosis eradication is just about over. But you know and I know that when the eradication forces stand still, the disease is likely to get a running start.

Let us take a look at some of the things that can be done to push tuberculosis eradication farther toward the goal of total eradication. This country is capable of it—it has a proud history of eradicating such diseases as contagious pleuropneumonia, tick fever, and nine different outbreaks of foot-and-mouth disease.

Tuberculosis is not as formidable an enemy as foot-and-mouth disease, which spreads with exceptional rapidity. That may be one of our difficulties—the team just doesn't train as hard for the warm-up games as it does for the more crucial events. We need to get into better training for the regular games on the schedule. Otherwise we are going to take a walloping from an underrated opponent.

We can take a leaf out of the book on combating foot-and-mouth and other exotic diseases. One of the most important things is tracing the source of infection, keeping suspicious cases and exposed animals and herds under close surveillance. This should be done immediately. This principle is too often overlooked in tuberculosis eradication. We have put too much dependence on finding reactors by routine testing.

When the incidence of disease is down to one-tenth of one per cent of the animals

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1 Dr. A. F. Ranney, Chief, Tuberculosis Eradication Section, Animal Disease Eradication Branch, Agricultural Research Service, United States Department of Agriculture.
tested, the return is very small. We have to test nearly 1,000 animals in about 45 herds to find a case of the disease by this means.

Too much emphasis, perhaps, has been placed on the number of animals tested, bearing in mind that we test only about one-tenth of the total cattle in the country in a given year. Of course, the testing is more or less selective in giving special consideration to areas and herds where experience has shown that more reactors are likely to be found.

What has been underemphasized, in all probability, is tracing back immediately the disease history of each tubercular animal. We need to study the history of each infected animal in an attempt to determine if possible whether the animal became infected on the premises where found or whether the infection came from another herd. Locating and testing the herd from which the infection came may help us to locate other infected animals and remove them for slaughter before they have an opportunity to spread tuberculosis to other herds. Furthermore, animals that have been removed from an infected herd should be traced and tested. Each animal moved from an infected herd must be considered dangerous and capable of spreading the disease to others unless it goes directly to slaughter without exposing additional animals en route.

In this day of highly mobile livestock industry, these investigations may be quite complex and take considerable time and effort. But, because they begin with the infection itself, they are likely to be more productive than routine testing of herds where we have no particular reason to suspect that infection exists.

One of the best places to start tracing the disease is where it is found in animals slaughtered for the market. Nearly 18.5 million were slaughtered under Federal meat inspection in fiscal year 1954. This represents approximately 80 per cent of the total slaughtered. The Meat Inspection Branch of the United States Department of Agriculture has done wonderfully valuable work in reporting carcasses showing lesions of tuberculosis. Initial stress on this work began in 1946, when Federal and State livestock officials were urged to use their best efforts in tracing infected animals back to their original herds. To show meat inspectors that

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<td></td>
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<td>463,159</td>
<td></td>
<td>478,975</td>
<td></td>
</tr>
<tr>
<td>Total reactors</td>
<td>10,811</td>
<td>0.11</td>
<td>10,886</td>
<td>0.11</td>
</tr>
<tr>
<td>Herds containing reactors</td>
<td>4,706</td>
<td>1.01</td>
<td>4,704</td>
<td>0.99</td>
</tr>
<tr>
<td>Reactors per infected herd (average)</td>
<td>2.3</td>
<td></td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>Herds tested to find one reactor (average)</td>
<td>43</td>
<td></td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Animals tested to locate one reactor (average)</td>
<td>895</td>
<td></td>
<td>940</td>
<td></td>
</tr>
</tbody>
</table>
their reports were being followed up, Federal veterinarians in charge of field stations were asked to write a letter to the meat inspector, informing him of the results of each investigation.

A new and more complete form was provided for meat inspectors in 1951, for their use when reporting cases of tuberculosis found on regular kill. Meat inspectors were urged to furnish all information available to them that might assist in identifying and tracing the infected animal back to its herd.

It is worth noting that 15 per cent of the total reactors found during the past year were located by this means. Sometimes, because of the frequent movement of animals, tracing the source of infected cattle has aspects of following clues in detective work. A couple of examples will serve to illustrate some of the problems and how they may be overcome. These things can, and do, happen anywhere, and no criticism is implied of the States from which these examples are drawn.

A Jersey cow was slaughtered at a Federally inspected plant in Prattsville, New York, July 17, 1953. She bore sales tag No. 492 and ear tag AR-24552. She had been brought to the slaughterhouse by a dealer from Ballston Spa, New York. When the carcass showed lesions of tuberculosis, an attempt was made to trace the animal through the dealer. He was unable to provide records that might lead to the source of infection. A State field veterinarian was given the ear tag number and the name of the veterinarian to whom the tag had been issued. It was, therefore, relatively simple to trace the animal back to the herd near Ballston Spa. This herd of 25 animals was retested and a reactor was found.

However, trouble developed at this point, for the herd in which the tag had been used originally had been dispersed and the cattle then on the premises were different animals. A great deal of effort went into tracing the sales from the original herd, but neither records nor memories provided the necessary information. The field veterinarian then investigated the town mortgage records in the three towns nearest the herds. In these records he found a mortgage covering the cow carrying ear tag AR-24552. He traced the animal to a farm near Waterford, New York. The herd of 75 animals was retested and 15 reactors were found.

A more involved story, which required the diligence of men battling tuberculosis in seven States, is that centering around a roan Shorthorn bull slaughtered in a Federally inspected plant at Frederick, Maryland, June 4, 1953. Fortunately, the animal was registered and bore a tattoo number. He was traced back to a herd in Adamstown, Maryland, thence through another in Falling Waters, West Virginia, to his point of origin near Martinsburg, West Virginia. The 176 animals in the Adamstown herd were tested and found negative. The same story resulted from testing 33 animals in the herd at Falling Waters. But the 71 animals in the herd where the bull was raised showed 32 reactors which were disclosed on the initial test following the tracing. A two-way investigation then began to find, if possible, what brought the infection into this herd and whether any infection had gone out from it to other herds.

The investigators were able to trace back to the purchase of 7 animals in Maryland, 20 in Illinois, and an undetermined number in Virginia. The origin of the infection was not definitely found.

Eleven herds in West Virginia were tested revealing six reactors in four herds.
Some of these herds had received animals from the infected herd. Others were closely associated with the herd. In tracing animals sold from the original herd, it was found that they went to two premises in Virginia. A total of 238 animals were tested in these two herds. Eight Shorthorns from the infected herd had been consigned to a sale in Tennessee and had been purchased by three buyers. A total of 104 animals were tested on these premises and 3 reactors were found in 2 herds. Two cows had been shipped to a buyer in North Carolina, and tests of them proved negative. One of these was shipped to Florida, and, when tested with four other animals, all were found negative.

To sum up, more than 1,000 animals were tested in 25 herds as a result of the lesions found on the carcass of the Shorthorn bull in Frederick, Maryland. Seven foci of infection were located in two States and 41 cattle were found to be reactors.

### TABLE II

**Comparative Results of Tracing to Herds of Origin Animals that Showed Lesions of Tuberculosis Under Federal Meat Inspection During Two Fiscal Years**

<table>
<thead>
<tr>
<th></th>
<th>1953</th>
<th>1954</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Numbers</td>
<td>Per cent</td>
</tr>
<tr>
<td>Cattle slaughtered (not including TB reactors)</td>
<td>15,204,998</td>
<td></td>
</tr>
<tr>
<td>Carcasses retained for TB (not including TB reactors)</td>
<td>1,406</td>
<td>.009</td>
</tr>
<tr>
<td>Investigations completed and reported back from field</td>
<td>309</td>
<td></td>
</tr>
<tr>
<td>Lesion cases on completed reports</td>
<td>337</td>
<td>24</td>
</tr>
<tr>
<td>Cases traced to herd of origin or accounted for</td>
<td>212</td>
<td>68.6</td>
</tr>
<tr>
<td>Herds tested (herds of origin and associated herds)</td>
<td>228</td>
<td></td>
</tr>
<tr>
<td>Herds with reactors</td>
<td>65</td>
<td>28</td>
</tr>
<tr>
<td>Reactors found</td>
<td>741</td>
<td></td>
</tr>
<tr>
<td>Reactors per herd tested (average)</td>
<td>3.25</td>
<td></td>
</tr>
<tr>
<td>Reactors per infected herd</td>
<td>11.4</td>
<td></td>
</tr>
<tr>
<td>Reactors found per investigation (average)</td>
<td>2.4</td>
<td></td>
</tr>
</tbody>
</table>

During the fiscal year 1954, in the United States as a whole, 1,299 carcasses were found by meat inspectors to have lesions of tuberculosis. Of this number, 577 cases were included in field investigation reports, indicating that an effort was made to trace the disease back to its origin. This represents 44.4 per cent of the lesion cases, and shows a distinct improvement over the fiscal year 1953, when 24 per cent of these cases were investigated. In some instances these cases have been traced back against seemingly impossible odds. Some States show a better record than others in tracking down the source of infection. The record is good but spotty. We are
Potential Results to be Gained by Tracing Lesion Cases

Table III

<table>
<thead>
<tr>
<th></th>
<th>Results of Tracing Lesion Cases</th>
<th>Potential Reactors If Able to Identify Origin of All Retained Carcasses</th>
<th>Potential Reactors Based on Adequate Meat Inspection in All States and/or Municipalities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Per cent</td>
<td>Number</td>
</tr>
<tr>
<td>Carcasses retained...</td>
<td>1,406</td>
<td></td>
<td>1,299</td>
</tr>
<tr>
<td>Lesion cases investigated</td>
<td>337</td>
<td>24</td>
<td>577</td>
</tr>
<tr>
<td>Tracing efficiency...</td>
<td>212</td>
<td>69</td>
<td>453</td>
</tr>
<tr>
<td>Meat inspection†...</td>
<td></td>
<td></td>
<td>80</td>
</tr>
<tr>
<td>Total reactors...</td>
<td>10,811</td>
<td></td>
<td>10,886</td>
</tr>
<tr>
<td>Reactors-tracing‡...</td>
<td>741</td>
<td>7</td>
<td>1,613</td>
</tr>
<tr>
<td>Projected increase over</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1954...</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Based on the number of carcasses retained and reactors found during the fiscal year 1954.
† Estimated 80 per cent of commercially slaughtered cattle receive Federal meat inspection.
‡ Reactors found as a result of tracing lesion cases.

still finding less than half of these sources of infection, and we ought to do better. Some of the States need to improve their performance in this direction.

Of the 485 herds tested in the course of tracing lesion cases, an average of 3½ reactors were found per herd. The results are very favorable compared with routine testing, for in these cases we are working from an actual occurrence of the disease, found as a result of routine meat inspection. The disease is there and it had to come from somewhere. The source can be found in a majority of cases, if enough diligent work is put into searching it out.

In New York State, for instance, where excellent work had been done in following up lesion cases, 493 reactors were found during calendar year 1953 as a result of tracing the source of lesions found on regular kill. These reactors represented 38 per cent of the total found in the State last year, and 43 per cent of the total reactors showing lesions. Figuring an average cost for finding a reactor in field tests, it was estimated that the net value of each report of tuberculous cattle located on straight kill was more than $4,500. If this same figure could be applied to each of the 552
completed reports of investigation on lesion cases in the Nation, then their net worth in tuberculosis eradication was more than $2.5 million.

One of the reasons why we have been able to trace fewer than half of the lesion cases back to their point of origin is because of the lack of adequate identification of animals sent to market. In the Eastern States and in the dairy areas, perhaps better than 75 per cent of the animals are eartagged. This is helpful identification, and many of these animals can be traced. Brands can be followed and traced in many of the Western States, but branding laws are by no means uniform. In most auction markets, a sales tag with a number is placed on each animal prior to the sale. But in altogether too many cases it is impossible to trace an infected animal back to its herd of origin. We are making a broadcast appeal to meat inspectors, packers, cattle dealers, operators of livestock auction markets, commission firms, veterinarians, and others closely associated with the handling of cattle to see that adequate records are maintained to facilitate the tracing of infected animals.

I have stressed, and indeed overstressed, the importance of tracing lesion cases in order to make the point that this phase of the program can be worked out more effectively than it has been.

This Association and those of us working on this problem in Government are committed to the complete eradication of tuberculosis in this country. It can be done, and we take this opportunity to solicit the aid of everyone concerned to help us finish the job.

Before closing, I want to add a couple of items about other aspects of tuberculosis eradication.

**AVIAN AND SWINE TUBERCULOSIS**

A new film on avian tuberculosis, *Vicious Circle*, color and sound, 16 mm., has recently been completed and distributed to various Extension Service film libraries and field stations. This film is available for showing. It is a good one, and should assist in enlightening the public about this problem.

Studies are continuing on the subject of setting up a more comprehensive avian-swine tuberculosis eradication program, which is badly needed in this country.

Swine tuberculosis, as measured by lesion cases found in straight kill, shows a little more favorable picture this year than last. During fiscal year 1954, carcasses showing lesions amounted to 3.9 per cent of the total compared with 4.3 per cent the year before.

**PARATUBERCULOSIS**

Testing for paratuberculosis (or Johne's disease) continued during the past fiscal year in 24 States and the Territory of Hawaii. Tests were made on 8,837 animals, of which 5.3 per cent were reactors. About one-half of the total animals tested were in the three States of Pennsylvania, Washington, and Wisconsin.
REPORT OF COMMITTEE ON TUBERCULOSIS

H. A. MILO, Harrisburg, Pennsylvania, Chairman; C. G. BRADT, Ithaca, New York; F. BUZZELL, Augusta, Maine; J. W. GREEN, Indianapolis, Indiana; O. HALL, Ottawa, Ont., Canada; H. W. JOHNSON, Beltsville, Maryland; T. L. JONES, Guelph, Ont., Canada; J. C. NOWLEN, Sycamore, Illinois; H. J. O'CONNELL, Madison, Wisconsin; W. SHANNON, Boston, Massachusetts; W. L. SIPPEL, Tifton, Georgia; R. S. SMILEY, Columbus, Ohio

The members of the Tuberculosis Committee recommended that the uniform methods and rules for the establishment and maintenance of tuberculosis-free accredited herds of cattle and modified accredited areas, as unanimously adopted by the United States Livestock Sanitary Association, September 25, 1953, and approved by the Bureau of Animal Industry, effective December 16, 1953, be carried in effect in their entirety.

In order to determine how the various States were handling their tuberculosis control and eradication programs, 50 questionnaires were mailed and 47 were returned, answering the questions set forth in the questionnaire.

In summarizing these questionnaires, it is found that many interesting facts have been revealed, and, as a result, your Committee submits the following recommendations:

1. Promote a well planned program of education by enlisting aid of both state and Federal extension services, Veterinary Medical Associations, livestock organizations, and the livestock industry, especially in areas where a complacent attitude appears to prevail. Veterinary schools should devote more time in the instruction of students relative to tuberculin testing and they should be fully acquainted with the laws and regulations in existence in the State in which they intend to practice.

2. Broaden the service for tracing straight slaughter cattle revealing lesions of tuberculosis, and inaugurate a tag, tattoo or brand recording system in all States so that cattle of this nature may be readily traced to the herd of origin.

3. Extend the program to include tuberculin testing of swine herds and poultry flocks, where it is thought they could be a factor in the transmission of tuberculosis.

4. Report cases where tuberculin reactors are disclosed to the Health Department of your State so that they may determine if members of the family could be responsible for spreading infection in the herd. Report so-called breaks in herds having been previously negative over the years.

5. Your Committee especially urges all States to follow the minimum health rules and regulations of the Federal Bureau of Animal Industry effective December 16, 1953, and if these rules and regulations are strictly adhered to, there will be very little reason for apprehension that this troublesome and costly disease will again gain nourishing roots in our livestock industry, and thus nullify the excellent results that have been achieved to date through the cooperation of many splendid organizations.
CUTANEOUS PAPILLOMATOSIS (WARTS) OF CATTLE

Lincoln, Nebraska

Cutaneous papillomatosis or warts is an infectious disease of the skin caused by viruses which stimulate epithelial cells leading to growth of the wart.

Papillomas occur in a number of different kinds of animals. They have been produced with virus preparations in many species: the oral papilloma of the dog (1), the common wart of man (2), papilloma in rabbits (3), oral papilloma of the rabbit (4), a papilloma of the skin of the horse (5) and the oral papilloma-like lesion in the mouth of cattle (6). All of these different virus agents cause proliferation of epithelium and yet the agents are quite distinctly different. The agent causing warts on the skin of cattle is capable of causing a marked stimulation of connective tissue in the skin of the horse. The lesion produced resembles a sarcoma except that it is self-limiting and will disappear of its own accord (7). While this can be readily produced on the horse with bovine material, transfer from horse to horse is difficult, perhaps because the virus is masked. Warts have been described on the skin of a number of other animals but the descriptions contain no mention of attempts at experimental transmission or a search for a causative virus.

Cattle are most frequently affected of the domesticated animals. The disease is widespread throughout the world and in countries with large populations of cattle it causes economic loss. Some of this loss is due to damage of the hide which is spoiled for the manufacture of leather (8). Warts on the teats may interfere with milking. Moulton (9) observed squamous cell carcinomas developed from warts on the udder of goats with metastasis to a lymph node in one case. Such a transition to malignancy has never been reported in bovine papillomatosis. The Shope papilloma of the midwestern wild cottontail rabbit is of interest in this connection. When the Shope papilloma is experimentally transferred to the domestic rabbit, some of the benign papillomas become transformed into malignant carcinomas (10). Occasionally extensive warts may affect the health of the animal. In some herds relatively more animals may be affected and the disease is therefore more serious. The exhibition and sale of purebred animals may be adversely affected because of the presence of warts. Additional loss can occur in breeding animals from fibropapillomas of the genitalia (11) which McEntee (12) has shown to be due to the virus of the ordinary bovine wart. A fibropapilloma of the penis in a bull may render him unsuitable for use. In the female the fibropapillomas of the vulva and vagina seem to be self-limiting (11).

So-called vaccines for bovine papillomatosis have been commercially available for a number of years and their use has led to many opinions concerning their efficacy. The commercial products and autogenous vaccines (prepared with wart materials from the same herds in which they are used) are nearly always recommended and used for treatment of existing papillomas rather than prevention of

1 Published with the approval of the Director as Paper No. 665, Journal Series, Nebraska Agricultural Experiment Station. University of Nebraska.
the disease. Treatment of a disease by the addition of more virus or antigen to that already existing in the animal is questionable and lacks sound theoretical support. There is even less justification for the use of so-called vaccine prepared from bovine papilloma material for the treatment of oral papillomatosis of the dog since the two conditions are caused by two distinctly different viruses.

The basis for so-called vaccine therapy seems to be a joint report by a German dermatologist and a veterinarian (13). The dermatologist had inactivated ground up human wart material with heat, and used it as a treatment for warts in man. He stated that he obtained good results in about 75 per cent of the cases after 10 to 20 injections. He also questioned whether this was a real effect or "suggestive" therapy. The dermatologist wished to eliminate the psychological factor and first turned to experimental animals such as guinea pigs, rabbits and mice. He was unable to produce papillomatosis in these species. Therefore, with cooperation of the veterinarian, he used natural cases of the disease in cattle. The report of Biberstein and Sussenbach (13) relates trials in four instances involving from one to six affected animals in different herds. One trial will serve as an example of their results: "Of six affected animals in a herd, two had an especially aggravated form of papillomatosis; one was left untreated as a control, it died after extensive spreading of the warts; the other five were cured with four applications of injections of 10 cc. of the vaccine". So far as we know, adequately controlled tests for so-called vaccine therapy of warts in cattle, have not been made. Such a test would involve treatment of every other case in affected herds, leaving one half as untreated controls.

Some veterinarians have discontinued the use of wart vaccine and have obtained satisfactory results by removing six to ten of the smaller warts by manual traction. Following this, they expect improvement in two to three months (14). Rapid regression of oral papillomatosis has also been noted in the dog following removal of only a few growths. Hormones have been used for treatment of warts with presumed beneficial results: diethylstilbestrol and colchicine for oral warts in the dog (15) and estrogen in papillomatosis in cattle (16). It must be kept in mind that papillomatosis caused by virus is always a self limiting disease and considerable variation occurs in its duration. We need much more information concerning the natural disease as well as the experimental form of the disease.

An outbreak of warts in a group of 110 Hereford cattle provided some interesting information (17). About three-fourths of the animals developed warts during a two-and-a-half-year period. The cattle were kept in several pens and the first cases occurred in four distinct areas. The source of original infection could not be established. Most of the new cases could be traced to direct contact with previously affected animals and some appeared to arise from indirect contact.

The incubation period, or period from contact with an affected animal until papillomas were evident on the exposed animal, varied from three and a half to four months, which is a little longer than the incubation period of three weeks to two months noted in experimentally produced papillomas. When once evident, the papillomas lasted from one to five and a half months, which is about the same as observed in the experimentally produced disease. Most of the warts were first noted in the region of the neck, chin, shoulder and dewlap. Very likely the possi-
bility for exposure of these areas through wounds and abrasions was an important factor. There were two episodes of the outbreak (Fig. 1) which may represent a single infection or may represent two outbreaks with different strains of the agent. In the first episode, lasting thirty weeks, 57 animals became infected under lot conditions. Two years later, 22 cases developed on pasture. In addition 32 animals previously affected with papillomas became reinfected during the second episode. Reinfection must have been due to loss of immunity or the second episode was another outbreak caused by an immunologically different agent.

Shope (18) found that rabbits could be immunized against infectious papillomatosis by two intraperitoneal injections of either infectious or noninfectious rabbit papilloma suspensions. He believed the ability of the noninfectious suspensions to immunize was evidence that they contained papilloma virus even though it could not be demonstrated by the usual infection test. It therefore seemed logical to use the so-called vaccines in cattle in an attempt to immunize them against a subsequent experimental challenge with active bovine papilloma material. This was done with three groups of 27 calves each (19). One group received commercial wart vaccine prepared from bovine tissue. Another group received commercial bovine wart vaccine prepared from chicken embryos and the third group were nonvaccinated controls. Two 20 ml. doses of vaccine were given subcutaneously two weeks apart and the challenge of immunity was made about three weeks after the last injection of vaccine. Three strains of challenge material were used; one came from a herd in Iowa and the other two came from widely separated herds in Nebraska. Typical warts developed at the sites of scarified inoculation and a nodular reaction at the site of intradermal exposure of the skin (Fig. 2). The calves receiving the vaccine prepared with chicken embryos had essentially the same results as the

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**Fig. 1.**—Graphic representation of the time of appearance of 82 cases of papillomatosis in cattle during two episodes of the disease. Reinfection occurred in 32 of the cattle during second episode. The first case was noted May 12, 1949 and the last new case was observed September 13, 1951. The dots also show the interval between observations (17).
Fig. 2.—Experimental growths fifty-nine days after inoculation with three strains (A, B, C) of bovine papilloma agent. Areas A, B, and C illustrate the nodular type of growth produced by intradermal inoculation. Areas a, b, and c represent papilloma-like growths which followed inoculation of scarified skin (19).

control calves. The calves receiving bovine tissue vaccine had about the same type of reaction in the connective tissue but none of them showed an epithelial reaction. This indicated that the vaccine did immunize the epithelium. In the same report some observations were made on old cows which had recovered from or were still affected with natural papillomas. The previous natural infection did immunize the epithelium so that typical warts were not produced. The animals which had recovered from two attacks of the disease showed less response of connective tissue to challenge exposure than those which had had only a single previous episode of warts.

A criticism of the above experiment was that there might have been an antigenic difference between the vaccine and the materials used for challenge of the immunity. An experiment was therefore planned (20) in which the cattle were
Fig. 3.—Growth from four papilloma virus preparations in calves vaccinated with various materials. The control group consisted of 16 calves and all others of 13 calves each. Calves received two doses of vaccine in amounts indicated. The results shown represent growth from virus strains 30 and 200 (30 B = strain 30 in bovine tissue and 30 C = strain 30 in chicken embryo tissue). These were inoculated both intradermally to stimulate connective tissue and on scarified skin to stimulate epithelium. Each immunized group can be compared to the controls.
immunized with bovine tissue vaccine and a chicken embryo vaccine prepared from the same strain of papilloma virus which was used for challenge. Two commercial vaccines were used in other groups of calves in the same experiment. Eight groups of 13 calves each were used. Some received two 5-ml. doses and others two 20-ml. doses of vaccine. A ninth group of 16 calves served as controls. The immunity produced was challenged six weeks after the last injection of wart vaccine by inoculation with four preparations of virus containing material (strains 30 and 200 in original bovine tissue and strains 30 and 200 cultivated in chicken embryos). In the nonvaccinated control group, strain 30 in the original bovine tissue gave reactions in 75 per cent of the calves (Fig. 3). The same strain grown in chicken embryo was active in only 25 per cent of the calves. Strain 200 of bovine papilloma was also reduced in activity from 50 per cent in bovine tissue to 5 per cent and less after being grown in the chicken embryo. The chicken embryo preparations of bovine papilloma virus were not effective in immunizing against even relatively mild challenge preparations of papilloma virus. The commercial chicken embryo wart vaccine seemed to actually increase the number of animals which reacted to the challenge preparations. The bovine tissue vaccine prepared from a laboratory strain did not protect completely against a challenge preparation when the vaccine was used in small doses but a slightly better degree of protection was obtained with larger 20-ml. doses. This difference related to dosage was not as marked in the case of the commercially prepared bovine tissue vaccine which immunized against only one of the two strains of agents used for challenge.

An interesting reaction is the response of connective tissue in the horse to the bovine papilloma virus. This reaction occurs very rapidly and is highly specific. We have used the horse as a test animal for some of our work. We have found (20) that serum from a horse bearing the connective tissue tumors produced by

![Fig. 4.—Areas 60 days after inoculation on scarified skin of different concentrations of bovine papilloma material. Beginning from the observer's left, the first vertical row is a dilution of 1:100, the second row a dilution of 1:1000, the third row a dilution of 1:10,000, the fourth row a dilution of 1:50,000, and the fifth row a dilution of 1:1,000,000. Slight growth was obtained at one site with a dilution of 1:1,000,000.](image-url)
bovine papilloma agent will neutralize the agent in rather high titer, whereas the serum from cattle with experimentally produced papillomas lacks this ability. The significance of this observation is not understood.

The size of the lesion developed in cattle seems to be related directly to the concentration of virus which is injected (Fig. 4).

CONCLUSIONS

Bovine papillomatosis is caused by a virus pathogenic for only cattle and horses. Loss may result from effect on health of the animal and reproductive ability of the bull or from reduced value of purebred animals, and damage to hides. It appears that we can immunize cattle against cutaneous papillomatosis. Different immunological strains of papilloma virus may exist. Material from chicken embryos inoculated with papilloma virus was low in pathogenicity for cattle and had little ability to immunize.

Some cattle are naturally resistant to experimental infection and the number showing such resistance varies with the strain of papilloma agent used. The duration of papillomatosis in individual animals varies to a very marked degree. There is no evidence that previous immunization has any effect upon the duration of experimental papillomatosis in cattle.

The use of so-called vaccines for bovine papillomatosis as a therapeutic measure has little foundation in controlled experiments. The results from clinical trials have been erratic. Such results should be critically examined because of the self limiting nature of the disease. A more careful analysis can be made when we have more knowledge about the disease.

REFERENCES


20. Unpublished data.
AN IMPROVED LEPTOSPIRA BACTERIN FOR THE CONTROL OF
BOVINE LEPTOSPIROSIS

ALBERT L. BROWN, PH.D.,* ALAN A. CREAMER, V.M.D., AND
SAMUEL F. SCHEIDY, V.M.D.*

The seriousness of the problem of leptospirosis in cattle has been adequately
discussed by others (1, 2) and it is generally agreed that an entirely satisfactory
program for preventing the spread of this disease has not been worked out. Such
a program would necessarily include (1) a rapid method of diagnosis, either by
serological procedures or by isolation of the organism, (2) treatment of infected
animals to eliminate the carrier state, and (3) vaccination of susceptible animals
to prevent infection.

In 1953, York and Baker (3) described the production and testing of a lepto-
spira bacterin grown in embryonated eggs for the immunization of cattle against
* Leptospira pomona. This bacterin, although the first developed specifically for
protection against L. pomona, differed from all other leptospira bacterins in that it
was grown in eggs instead of artificial culture medium. In attempting to produce
this egg bacterin, we became interested in ascertaining whether growth of the
T262 strain in embryonated eggs was responsible for producing a superior antigen
per se or whether it was the strain of leptospira that was responsible for the desira-
ble antigenic properties. It was found that the T262 strain grew about equally
as well in modified Stuart's medium as in eggs. The average growth from both sources
was approximately 125 million leptospira per ml. When the culture medium growth
was tested for its immunizing properties, it proved to be a better antigen than any
we had been able to produce in repeated attempts using over 25,000 eggs. Shortly
afterward it was found that the addition of small amounts of thiamine to the
culture medium increased the growth of the leptospira from four to six fold with a
corresponding improvement in antigenicity. The production of this culture medium
bacterin, its immunizing properties in cattle and guinea pigs and some suggestions
for its use are presented in this paper.

METHODS

Preparation of Bacterins

The medium used to grow the leptospira for the culture medium bacterin was a
modification of Stuart's medium made according to directions obtained from the
Army Medical Service Graduate School. In some cases this was further modified
by the addition of 2.0 μg/ml. of thiamine HCl. The medium was dispensed into
Blake bottles which could be incubated on their flat sides to give greater surface;
just before inoculation, inactivated hemolyzed rabbit serum in a final concentra-
tion of ten per cent was added aseptically. One ml. of an actively growing culture
of L. pomona strain T262 was used as an inoculum for 200 ml. of medium. The
bottles were incubated for 10 to 14 days at a temperature of 30 to 32°C. During
the incubation period, growth of leptospira was determined by a Petroff-Hausser

* Sharp & Dohme, Division of Merck & Co., Inc., West Point, Pennsylvania.
count. When the count was sufficiently high, the organisms were killed by the addition of thimerosal in a final concentration of 1:10,000. This also acted as a preservative. The bacterin was then frozen at -20°C and thawed in order to break up the leptospira. Finished bacterin was stored at 5°C.

In contrast to the egg bacterin, this bacterin is not lyophilized. In experiments to be reported elsewhere it has been found that the leptospira antigen is very stable in the liquid state. Bacterins aged for one month at 37°C show no significant loss in immunizing potency.

The egg bacterin was prepared according to published instructions (3) and was finished in the same manner as the culture medium bacterin.

**Potency Test for Bacterins in Guinea Pigs**

For purposes of comparing different lots of bacterin, a guinea pig test was used in which guinea pigs were inoculated with dilutions of bacterin followed by challenge with virulent leptospira. Guinea pigs received 1.0 ml. of bacterin diluted in sterile, physiological saline in the foot pad of the right hind foot. At the same time, a suitable number of control animals were set aside. All guinea pigs were kept in an air conditioned room and temperatures were taken and recorded twice a week during the immunization period. About 14 days after vaccination the test animals and the controls were inoculated with a virulent strain of *L. pomona* obtained from Cornell University,* known as the MLS strain. Following challenge, the temperatures of the guinea pigs were taken daily. Any temperature over 104.0°F was considered to be a specific response to the challenge infection. Partially immunized animals did not run so high a temperature nor for so long as did the normal control animals. Unvaccinated guinea pigs have responded uniformly with the prolonged temperatures characteristic of the infection.

**Method of Determining Antibody Titer of Serum**

A microscopic agglutination-lysis test was used to detect antibodies. Five-fold dilutions of serum in physiological saline with a final volume of 0.4 ml. were mixed with an equal volume of an active culture of *L. pomona* strain T262 grown for about six days in Stuart's medium. The final dilutions of serum were from 1:10 to 1:31,250. Tubes containing the mixture were incubated in a water bath at 30°C for three hours. Tests were read by examining 0.04 ml. under a standard sized cover slip with a darkfield microscope using 150× magnification. Tests were read as −, ±, +, and ++ using standard pictures as a reference (4). Both + and ++ readings were considered to be a positive test.

**RESULTS**

**Immunization Studies in Guinea Pigs**

Using the guinea pig potency test, several lots of egg bacterin were compared with several lots of culture medium bacterin. Some typical results are shown in Table I. Egg Lot 2 was from a pool of 14 liters of allantoic fluid. Egg Lot 3 was

* Kindly provided by Dr. James A. Baker to whom we are indebted for both the MLS and the T262 strains.
**IMPROVED LEPTOSPIRA BACTERIN**

### TABLE I

**Protection of Guinea Pigs by Typical Lots of Bacterin**

<table>
<thead>
<tr>
<th>Lot No.</th>
<th>Count</th>
<th>Dilution of Bacterin</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1/4</td>
<td>1/8</td>
</tr>
<tr>
<td>Egg 2</td>
<td>125 × 10⁶ est.</td>
<td>0/5*</td>
<td>1/5</td>
</tr>
<tr>
<td>Egg 3</td>
<td>125 × 10⁶ est.</td>
<td>1/5</td>
<td>3/5</td>
</tr>
<tr>
<td>CM-1</td>
<td>125 × 10⁶ est.</td>
<td>0/3</td>
<td>1/3</td>
</tr>
<tr>
<td>CM-3</td>
<td>530 × 10⁴ †</td>
<td>0/5</td>
<td>0/5</td>
</tr>
</tbody>
</table>

* Number guinea pigs temperatures exceeding 104.0°F.

† Petroff-Hausser microscopic count.

from a pool of 64 liters of allantoic fluid. Culture medium bacterins were from small lots prepared in the laboratory.

From the results presented, it may be seen that the culture medium bacterin immunized the guinea pigs more effectively than did the egg bacterin when lots containing approximately the same number of leptospira were compared. Experiments, to be reported elsewhere, with bacterins known to contain the same number of leptospira as determined by actual Petroff-Hausser counts have given similar results. One explanation for the superiority of the culture medium bacterin may be attributed possibly to the 10 to 14 day incubation period during which time there may be considerable lysis of leptospira with resulting accumulation of antigen, undetectable, of course, by a microscopic count. The culture medium bacterin containing 530 million leptospira per ml. was grown in medium supplemented with thiamine and was obviously far superior to any of the other bacterins tested.

Attempts were made to determine whether protection of guinea pigs against infection could be correlated with antibody titers. Guinea pigs were immunized as previously described with 1:4, 1:16, and 1:64 dilutions of the culture medium bacterin Lot 3 containing 530 million leptospira per ml. Two weeks following immunization they were bled and after a four day rest they were challenged with virulent leptospira. Two weeks after the temperatures of the control animals had returned to normal, they were again bled. The two samples of blood were tested for agglutination-lysis antibodies in the manner described.

Typical results of this experiment are presented in Table II.

From these results, it may be seen that in general those guinea pigs that received the largest amounts of bacterin developed the highest antibody titers. However, there was considerable variation in response among the animals in each group and the importance of the agglutination-lysis titer as an index of immunity has certainly not been determined from this experiment. Most immunized guinea pigs with a pre-challenged titer of less than 1:10 were found to be immune. It should be re-emphasized, however, that in immunized animals the course of infection was usually only a one day fever with no other evidence of illness compared to a three to five day fever in the control group with losses in body weight up to 25 per cent.
### TABLE II

**Results of Immunization of Guinea Pigs with Leptospira Bacterin**

<table>
<thead>
<tr>
<th>Dilution of Bacterin</th>
<th>Guinea Pig Number</th>
<th>Pre-challenge Titer*</th>
<th>Febrile Response†</th>
<th>Post-challenge Titer*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>-1:10</td>
<td>-</td>
<td>+1:250</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-1:10</td>
<td>-</td>
<td>+1:250</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>+1:10</td>
<td>-</td>
<td>+1:10</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>+1:50</td>
<td>-</td>
<td>+1:10</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>+1:50</td>
<td>-</td>
<td>+1:50</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>±1:10</td>
<td>-</td>
<td>+1:10</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>+1:250</td>
<td>-</td>
<td>+1:250</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>±1:10</td>
<td>-</td>
<td>+1:10</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>+1:250</td>
<td>-</td>
<td>+1:1250</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>±1:10</td>
<td>-</td>
<td>+1:1250</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>+1:10</td>
<td>-</td>
<td>+1:10</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>+1:50</td>
<td>-</td>
<td>+1:50</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>-1:10</td>
<td>-</td>
<td>+1:10</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>-1:10</td>
<td>-</td>
<td>±1:10</td>
<td></td>
</tr>
<tr>
<td>1:64</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>+1:10</td>
<td>+ (1)</td>
<td>+1:31,250</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>-1:10</td>
<td>-</td>
<td>+1:1250</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>+1:10</td>
<td>+ (1)</td>
<td>+1:6250</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>-1:10</td>
<td>-</td>
<td>+1:1250</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>-1:10</td>
<td>-</td>
<td>+1:1250</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>±1:10</td>
<td>-</td>
<td>+1:50</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>-1:10</td>
<td>+ (3)</td>
<td>+1:31,250</td>
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</tr>
<tr>
<td>36</td>
<td>-1:10</td>
<td>-</td>
<td>+1:250</td>
<td></td>
</tr>
<tr>
<td>Controls not</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>immunized</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Not tested</td>
<td>+ (5)</td>
<td>+1:250</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Not tested</td>
<td>+ (4)</td>
<td>+1:1250</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Not tested</td>
<td>+ (3)</td>
<td>+1:250</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Not tested</td>
<td>+ (4)</td>
<td>+1:1250</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>Not tested</td>
<td>+ (5)</td>
<td>+1:250</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>Not tested</td>
<td>+ (6)</td>
<td>+1:1250</td>
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<tr>
<td>45</td>
<td>Not tested</td>
<td>+ (5)</td>
<td>+1:1250</td>
<td></td>
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<tr>
<td>46</td>
<td>Not tested</td>
<td>+ (4)</td>
<td>+1:250</td>
<td></td>
</tr>
</tbody>
</table>

* In this and subsequent tables agglutination-lysis titers are expressed as — or + at the serum dilution indicated.

† Febrile response: — indicates no elevation of temperature; + indicates temperature of 104°F or above. The figures in parentheses show the duration of fever in days.

In direct contrast to this, two animals which received the 1:64 dilution of bacterin, developed a pre-challenge titer of 1:10 but showed a febrile response following challenge and subsequently developed very high titers indicating that they were actually infected.

In the guinea pigs immunized with the largest amounts of bacterin there was less difference between their pre-challenge and post-challenge titers than in those
improved with the higher dilutions of the vaccine. This is believed to indicate only a slight secondary response to infection in the animals immunized with the largest amounts of bacterin in contrast to the pronounced secondary response in those animals receiving the more dilute bacterin.

**Immunization Studies in Cattle**

In studies in cattle we have immunized thus far 32 animals with the culture medium bacterin. These animals were in two groups. The first group consisted of 15 dairy type calves purchased locally in Pennsylvania. The calves were brought into our barn, held in isolation, and tested for agglutination-lysis antibodies immediately after receiving them and again after a three week observation period. With both sets of sera, all were found negative at a 1:10 dilution. Ten of these calves were immunized by inoculating them subcutaneously in the neck with 5.0 ml. of culture medium bacterin Lot 3 and five calves were held as normal controls. Blood samples were taken from the immunized animals at weekly intervals and tested for antibodies. The results of the tests for antibodies are presented in Table III along with some other data to be described later.

It can be seen from this table that all calves developed an antibody titer. With one exception, these calves had developed their maximal antibody titers within one week after they were vaccinated. The one exception did not produce sufficient antibody to be positive at a 1:10 dilution of serum for six weeks but after this, its titer remained at this level.

Three weeks after immunization, five of the immunized calves along with the five unvaccinated control animals were challenged by inoculating them subcutaneously in the neck with 2.0 ml. of defibrinated guinea pig blood containing virulent *L. pomona* organisms of the MLS strain.

Following challenge, temperatures and blood samples were taken daily and the sera were tested for agglutination-lysis antibodies. Results of this experiment are presented in Table IV.

Unfortunately, the unvaccinated calves did not respond to challenge by showing

<table>
<thead>
<tr>
<th>TABLE III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agglutination-lysis Titer in Cattle Immunized with Culture Medium Bacterin</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Bacterin</th>
<th>No. Animals Inoculated</th>
<th>Post-immunisation Titers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>+1:10</td>
</tr>
<tr>
<td>1</td>
<td>Monovalent (C.M. 3)</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Monovalent (C.M. 3)</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Polyvalent</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Total......</td>
<td></td>
<td>32</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(25.0%)</td>
</tr>
</tbody>
</table>
a febrile response as regularly as did the guinea pigs. However, the antibody pattern of the unvaccinated calves is very similar to that of guinea pigs. The control animals developed high titers following challenge while the titers in the immunized animals remained approximately the same as before challenge. One may conclude, therefore, that the number of leptospira inoculated in the challenge dose was too small to produce a secondary serological response without multiplying in the animal. The rapid rise in titer in the control group was due to an active infection with or without clinical manifestation of disease. The remaining five cattle from this experiment are being followed for antibody titer each week and will be challenged at the end of six months.

The second group of cattle immunized was a herd of 24 steers. In this test the cattle were immunized by inoculating them with two different lots of bacterin and then determining their antibody response.

Cattle were inoculated with either 5.0 ml. of culture medium bacterin Lot 3 or with 5.0 ml. of a polyvalent bacterin made by combining four strains of *L. pomona*. Agglutination-lysis tests were performed on serum samples collected at the time of inoculation and two weeks later. Two steers were found to have low titers, positive at 1:250, both before and after vaccination and these two have been omitted from the data.

From the results presented in Table III, it would appear that there was not much difference between the immunizing ability of either bacterin or between the two groups of cattle, therefore, the results are combined. Since about 50 per cent of the cattle develop an antibody titer of 1:50, it may be concluded that this culture medium bacterin will produce a reasonable antibody response in cattle.

By way of comparison, Lot 2 of the egg bacterin, which was not found to be as effective in the guinea pig potency test, was used to immunize a small dairy herd in which there had been one case of leptospirosis diagnosed on the basis of isolation of the organism four months earlier. The dose of bacterin employed was 5.0 ml.

### TABLE IV

**Results of Vaccination and Challenge in Experimental Calves**

<table>
<thead>
<tr>
<th>Group</th>
<th>Calf No.</th>
<th>Titer of Serum Samples</th>
<th>Temperature and Indication of Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immunized</td>
<td>6080</td>
<td>-1:10</td>
<td>+1:10</td>
</tr>
<tr>
<td></td>
<td>6081</td>
<td>-1:10</td>
<td>+1:50</td>
</tr>
<tr>
<td></td>
<td>6083</td>
<td>-1:10</td>
<td>+1:50</td>
</tr>
<tr>
<td></td>
<td>6088</td>
<td>-1:10</td>
<td>+1:50</td>
</tr>
<tr>
<td></td>
<td>6089</td>
<td>-1:10</td>
<td>+1:50</td>
</tr>
<tr>
<td>Control</td>
<td>6086</td>
<td>-1:10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6090</td>
<td>-1:10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6092</td>
<td>-1:10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6094</td>
<td>-1:10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6095</td>
<td>-1:10</td>
<td></td>
</tr>
</tbody>
</table>
TABLE V

Agglutination-lysis Titer in Cattle Immunized with Egg Bacterin

<table>
<thead>
<tr>
<th>Pre-immun. Titer</th>
<th>Total No. Animals</th>
<th>Number Cattle with Post-immunization Titers*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>-1:10</td>
</tr>
<tr>
<td>-1:10</td>
<td>29</td>
<td>4</td>
</tr>
<tr>
<td>+1:10</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>+1:50</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>+1:250</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>+1:1250</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>+1:31,250</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

* Highest titer obtained from either 3 week or 11 week sample.

This bacterin was produced according to prescribed requirements and was intended for commercial distribution. Blood samples were taken before inoculation and then again at three weeks and eleven weeks following immunization. The results of this experiment are shown in Table V.

It can be seen from this table that in those animals that initially were negative at a 1:10 dilution of serum, a titer of 1:10 or a little higher usually developed. Four of the cattle, however, failed to develop demonstrable antibodies. All cattle in the herd were probably protected since data obtained from titers of their sera taken three months after vaccination would indicate that there was no further cases of leptospirosis. It would not be expected that their immunity would be as long lasting as in cattle inoculated with the culture medium bacterin in which the initial titer is on the average considerably higher.

DISCUSSION

The fact that the antibody titers obtained in cattle immunized with the culture medium grown leptospira bacterin are relatively low as compared to the titers found after actual infection with leptospira is not thought to indicate that the bacterin gives poor protection. The five calves immunized with this bacterin, that were subsequently challenged, were found to be protected. Their antibody titers ranged from 1:10 to 1:250. In all the other cattle which we have inoculated with the culture medium we have found similar antibody titers. Our experience with guinea pigs, which has been somewhat more extensive than cattle, has shown that these animals are protected against infection from massive doses of virulent strains of *L. pomona* when they have very low antibody titers (in some cases with no demonstrable titer). To obtain really high agglutination-lysis titers it is necessary to have an active infection. However, as shown in the guinea pig experiment it is not necessary to have high antibody titers to afford complete protection against infection. The use of guinea pigs for potency tests on this bacterin accurately reflects, in a laboratory test, what might be expected in cattle immunized with the same material. It is evident from the results obtained thus far that cattle form measurable antibodies even more readily than guinea pigs.

The fact that antibody titers are found for at least five months after immuniza-
tion encourages optimism that protection may last for at least this long. Undoubtedly, the higher the initial titer produced by a bacterin, the longer the animal is protected.

Since bovine leptospirosis caused by the strains of *L. pomona* now found in the United States is not believed to be a public health hazard to man, the primary need for immunizing cattle is to prevent economic loss to the owners. This bacterin, as now constituted, should be highly effective in accomplishing this. Because of the rapidity with which immunity develops and because of the length of time it remains effective, it should be useful in preventing the spread of leptospirosis in herds in which the disease has been diagnosed. The length of time the animals remain immune allows adequate time for the carrier state in infected cattle to clear up. As a practical prophylactic measure this culture medium bacterin is low enough in cost to encourage its widespread use in areas where leptospirosis is prevalent.

The problem of whether the bacterin should be polyvalent has been carefully considered with regard to other species of leptospira which have been identified by antibodies in the serum of cattle (2). On the basis of isolation of the infecting organism, *L. pomona* is the only species of leptospira of recognized importance in leptospirosis in cattle in the United States at the present time. If the need should arise it would be a simple matter to grow the required species of leptospira in culture medium and produce a polyvalent bacterin by mixing in the proper proportions. However, the need is for protection of cattle against *L. pomona* and this would be best accomplished by administration of the undiluted antigen.

**SUMMARY**

A new bacterin for immunizing cattle against infection by *L. pomona* is described. The leptospira are grown in a modified Stuart's medium supplemented with thiamine and the final growth ranges between 500,000,000 and 750,000,000 organisms per ml.

Tests in cattle show that 5.0 ml. of bacterin inoculated subcutaneously elicit sufficient serum antibodies to give a positive agglutination-lysis test at dilutions of 1:10 to 1:250, with most animals at a 1:50 level. It has been shown experimentally that these levels protect cattle against an artificially induced infection by virulent leptospira.

The results of immunological studies in guinea pigs have been correlated with the cattle test.

**BIBLIOGRAPHY**

President T. C. Green: Because of the importance of this subject I don't feel we should let Dr. Brown leave the platform until we have at least five minutes for discussion. I believe there are some microphones set up around the room, and we will use them in asking questions, please.

Voice: Dr. Brown, do you feel that your calves were adequately challenged?

Dr. A. L. Brown: It is very difficult to challenge cattle being sure you are going to get a uniform challenge. We started out by challenging one animal with our MLS strain, and we got a perfect response. It had a fever for five days, which ran at least 106°F. We isolated leptospira from the blood for six consecutive days in duplicate samples.

The animal was off its feed. We used the same strain of leptospira to challenge the other ten animals. Of the five control animals, three showed a fever but only one of them had the high fever. Their antibody titers all went up to a level of 6,250.

I have read a paper by Dr. Reinhart, which he gave recently, and he said he found that the most certain criterion of infection in cattle is the antibody titer, so we feel that by using these antibody titers we are really challenging the animals.

Dr. A. Quin: How many doses of that bacterin would be used in routine field use? Have you got that far yet, in prophylaxis?

Dr. A. L. Brown: One inoculation. We hope one inoculation will be good for at least six months.

Voice: How much difference in immune response do you obtain from the second injection of bacterin?

Dr. A. L. Brown: We haven't tried inoculating with the second injection.

Voice: Have you used any other animals for test animals beside the guinea pig, such as hamsters?

Dr. A. L. Brown: I did some work with hamsters. I am not crazy about working with hamsters. We have had such good results using guinea pigs, and such a uniform temperature rise when we challenge them, that we did not want to use hamsters, where you have to look for deaths to see if you have challenged the animals.
Livestock diseases create one of the greatest economic hazards to the dairy herd owner. Conservative estimates place the loss in the United States from bovine mastitis alone at $100,000,000 annually (4). This would appear to be a low estimate since in New York State we estimate that this disease costs our dairy farmers at least $25,000,000 a year from milk and dairy cattle losses and costs of treatment. A more satisfactory means of determining mastitis losses is obtained when we look at the improved economic situation that develops as a result of mastitis control. Cooperators with the New York State Mastitis Program who are controlling the disease, report savings from increased production and reduced cow losses as a result of mastitis control, of as much as one to two thousand dollars annually. One dairyman with a 50-cow herd reported a $2,000 savings the first year following introduction of a mastitis control program in his dairy.

There is no widespread herd disease problem that is more complex than that of bovine mastitis. It is also doubtful if there is any disease problem that dairy farmers are tackling less efficiently. This is a result of so many misconceptions pertaining to the cause and control of bovine mastitis and the value of treatments without prevention. This confusion exists in the minds of members of the dairy industry to a marked extent, and to a lesser extent, in the minds of veterinarians.

Recognition of the need for a clearer and more comprehensive conception of bovine mastitis control and its potentialities when a well-organized procedure is followed, was the chief reason for the establishment in 1946 of the New York State Mastitis Research and Control Program. This project was financed by the New York State Legislature as a result of demands made by many groups and individuals interested in the welfare of the dairy industry. In 1929, Udall (15) and Johnson at the New York State Veterinary College at Cornell University made an important contribution to mastitis control by the use of careful physical examination of the udder and its secretions as a means of diagnosing clinical mastitis and the classification of cows. They also employed laboratory diagnosis and checked environmental factors. The New York State Program is based on the experience of this early work as well as subsequent developments at Cornell and other institutions. At present the program has expanded the environmental, laboratory, and treatment studies and has simplified the physical examination.

The Program includes studies in basic research and field control. The field program was described by Dr. E. V. Moore, Ass’t. Comm. of Agriculture, New York State Department of Agriculture & Markets, when he announced the Program. He stated that “the objective of the Program was to take the knowledge of the research worker to the dairyman in easily understood language.”

There is a research laboratory at Ithaca and six field laboratories located at widely separated points. One of these is located at the Veterinary College and serves as a central laboratory.

* Supervising Veterinarian, Mastitis Control Program, N. Y. S. Veterinary College, Cornell University, Ithaca, New York.
Each field laboratory is staffed by a field veterinarian, laboratory technicians and other personnel needed to provide mastitis control service to dairy farmers and veterinarians within the State.

**DIAGNOSIS**

In addition to the incidence of udder pathogens, consideration is also given to the incidence of abnormal secretions and other symptoms of clinical mastitis. This provides the veterinarian with better diagnostic information and more definite evaluation of results of treatment. The incidence of abnormal secretions, from the farmer's standpoint, is of importance since the absence of abnormal secretions and the production of adequate quantities of high quality milk are closely related. Also, a dairyman can see the improvement in milk quality from an abnormal secretion standpoint much more readily than he can observe the elimination of micro-organisms.

Consideration of clinical symptoms of mastitis was further influenced by the fact that New York and metropolitan New Jersey require an annual health examination of dairy cows producing milk for human consumption. While this is a general health examination, much emphasis is placed upon the incidence of clinical mastitis, particularly insofar as abnormal secretions are concerned.

Herd examinations and surveys (5) are made by the field veterinarian in cooperation with a private practitioner. The private practitioner also frequently provides this service for his client without the assistance of the field veterinarian. An examination is made of each cow's udder and the secretions from every quarter whether or not this cow is lactating. Strict foremilk samples are taken from each teat of every cow in the herd. A black strip plate is used on all cows, and the brom-thymol blue test made when indicated. The samples are examined at the field laboratory for the presence of pathogenic organisms (6). Information covering the physical examination of the udder and milk and the culture of the milk samples, is placed on one report. The veterinarian as well as the farmer is provided with information pertaining to incidence of mastitis and also specific information pertaining to its control at the particular farm in question.

The Program might be described as a state aid program. The services of the field veterinarian and laboratory analysis of milk samples are at state expense. The dairyman pays his own veterinarian for the services he provides for herd examinations, collection of samples, and treatments.

Since the Program was established eight years ago, the volume of work has increased each year. A total of over 4,000 herd owners have received mastitis service. During the fiscal year 1953–54, more than 81,000 cow examinations were made at approximately 2,000 complete surveys and over 1,000 incomplete surveys.

The number of herd owners worked with constitutes approximately 5 per cent of the commercial dairy farms of the State. This, while not too large a percentage, does provide substantial basis for certain theories and conclusions.

Three hundred and thirty-nine herds (2), containing 10,504 cows, received service for the first time during the fiscal year 1953–54. Abnormal secretions were revealed in 13.6 per cent of the cows and 12.2 per cent of the quarters were infected with *Streptococcus agalactiae*. In 124 of these herds which received two or
more surveys, there was a 47 per cent reduction in abnormal secretions and a 72 per cent reduction of *S. agalactiae* infection.

**ETIOLOGY**

*Streptococcus agalactiae* is the organism most frequently referred to. In addition there are several others which we refer to as miscellaneous infections. Approximately 26 per cent are streptococci other than *S. agalactiae*, with 17 per cent revealing either staphylococci, coliform, *Pseudomonas*, paracoli, or one of several other pathogenic organisms. In rare instances such serious infections as ordinarily saprophytic mycobacteria (13, 14), and yeast-like organisms (11) have been recorded. The bacteriological agents that are present in most active cases of mastitis and in many of the essentially normal udders are well known. The reason why mastitis infection occurs in the udders of some cows and not in others in the same herd is not so well understood.

Fundamental research projects by Dr. J. M. Murphy, Veterinary Bacteriologist, New York State Veterinary College, are aimed at obtaining more information on some of the basic problems in mastitis. One of these problems is how infection gets established in the mammary gland. It has been assumed for years that the path is by way of the teat canal, and mastitis control efforts have long made use of sanitation and isolation as means of trying to prevent the spread of bacteria. It is possible, however, that with more detailed information there could be a more precise and, perhaps, a more economical control of the disease.

Challenging the gland in a controlled way with a specific organism (*S. agalactiae*) appeared to be the best approach under the circumstances. Of three possible ways of challenging—on the skin of the teat, into the teat canal, or into the milk in the teat—the latter was selected for initial study because of the prevailing theory that the milk contained a bacteriostatic or bactericidal property, stronger in some cows than in others, that could prevent infection from occurring.

Milk was removed from glands aseptically and inoculated with small numbers of the test organisms. It was found that, although there was a lag period of about five hours during which the organism did not grow, growth occurred in all normal milks and reached a significant level in 10 hours (7). Since 10 hours is equivalent to the time elapsing between the shorter of the two usual milking times, it was concluded that even a small number of *S. agalactiae* (less than 100), reaching the milk cavity shortly after a milking, would grow and cause an infection.

To confirm this in the living animal (8), an artificial infection pipette was designed by means of which the same small numbers of *S. agalactiae* could be placed directly into the milk in the teat cavity without losing the organisms in the process. The result was that all glands so inoculated became infected, thus confirming the *in vitro* results.

Because of this result, it was concluded that the next most likely place to challenge was the teat canal (9). A method of exposure was designed which employs a small sterile cotton swab 2 mm. in diameter. This is inoculated with *S. agalactiae* and inserted 3 mm. into the teat canal, which ranges in length from 8 to 13 mm.

It was found that this standard exposure resulted in 5,000,000 organisms being placed in the teat canal. By this means it has been determined that, during a period
of six months, some cows are completely susceptible (become infected upon repeated exposure) while others are completely resistant, and it appears that no immunity is imparted as a result of being infected (10). The most surprising thing, however, has been that in nearly 500 exposures of scores of glands the overall infection rate has been only 14 per cent. Thus the teat canal is definitely a true barrier to infection of the gland with *S. agalactiae*.

These studies are being continued in the hope that the path of infection may be more completely understood.

The fact that infection gains entrance into the udder through the teat end has been accepted for years but not much attention has been given to the possibility of individual cows or individual teats on the same cow, or to the nature of this resistant factor whatever it may be.

At present only *S. agalactiae* has been used. It is assumed that this work can be used as a pattern for further studies with other organisms.

Bang, in 1888, in a paper entitled “Causes of Mastitis in Cattle” referred to “defective milking associated with diseases of the tips of the teat” and the “droplet of milk beneath the orifice of the teat . . . immediately after milking”. Udall (15) in 1954, states, “The cause of mastitis falls under two main groups: (a) the badly infected cow, (b) insanitary stable and milking hygiene with special reference to protection of the udder.”

It is a well accepted theory that injury to teat ends no matter how slight, may predispose mastitis. The teat injury most frequently thought of is the stepped on teat or the badly lacerated teat which occurs from barb wire cuts or similar accidents. Much more frequent and less well recognized trauma to teat ends occur as a result of improper use of the milking machine. Incorrect vacuum levels, defective pulsators, and prolonged milking, create injuries to the teat ends that are evidenced by oedematous or reddened teats and calloused or vegetative teat ends. It is apparent that minute injuries caused by improper use of the milking machine are an important factor in the incidence of mastitis.

The observations of Bang, Udall, Murphy, and many others, constantly emphasize the fact that control of mastitis can be accomplished only through adequate preventive measures. Murphy’s work indicates several possibilities. It indicates that certain cows may have some sort of a defense mechanism in the end of the teat that protects the udder from mastitis infection. It also indicates that if the infection gets into the udder it can develop and cause trouble. A very important aspect of this study is the fact that mastitis infection in the non-resistant cows was removed when treated, but they became infected again when exposed to infection. This emphasizes the fact that it takes more than treatment alone to control mastitis. The disease can be successfully handled only when it is attacked from a herd stand-point and not from an individual stand-point.

**MORE EFFECTIVE ENVIRONMENTAL FACTORS**

The approach to mastitis control in New York State is based on a combination of clinical and laboratory diagnosis and on prevention and treatment. We are guided by knowledge provided by research and experience in all classes of herds.

No less than three attempts have been made to evaluate the relative importance
of the various environmental factors predisposing to mastitis. This is difficult to do since most dairymen usually do some things well, and may neglect others. Naturally this creates a factor of error that is difficult to correct.

Actually these studies do not provide information that is amazingly new. They do instead provide the relative importance of the value of various environmental factors. This makes it possible to emphasize the factors of greatest importance and deemphasize or ignore those of lesser importance. A more simple and practical approach to the control of mastitis is the result.

Following are several environmental factors developed from field survey and laboratory culture records covering work done previous to 1951 (3) and listed in order of relative importance as shown by statistical data. It should be recognized, however, that neglect of any one factor may easily destroy the benefit that might be derived from practice of all the others.

**LIST OF ENVIRONMENTAL FACTORS**

_In order of their importance_

1. Use of milking machine.
3. Dipping of teats in an antiseptic solution after milking.
4. Stall beds of adequate size, clean, and provided with adequate bedding.
5. Absence of teat and udder injuries
6. Absence of mud and dust in barnyards, lanes, and pastures.
7. Mastitis-free replacements.

**Proper Use of the Milking Machine.** All-around good herd management is a must if we succeed in the control of bovine mastitis, but “use of the milking machine” stands at the head of the list. *It means a machine in good mechanical condition, equipped with clean inflations, in good repair and properly used.* Without all three of these, the control of mastitis cannot be satisfactory. Frequently a dairyman who is utilizing good diagnostic and treatment practices, and maintains other good management practices, fails in his efforts to control mastitis simply because he does not adhere strictly to good milking methods. The incidence of mastitis is lower when the machine is equipped with rubber parts that are kept clean and in good repair and used properly on the cow. It is also imperative that the entire system is kept in good mechanical condition and that the vacuum is correct for the machine used.

**Provide Two Sets of Inflations and Use Each on Alternate Weeks.** No matter how thoroughly the rubber parts are cleaned after each use, they will gradually absorb a certain amount of milk fat. In a study in England of deterioration of rubber parts of milking machines (1) it is suggested that the inflation absorbs milk fats from milk trapped between the rubber and the teat. It is also stated that “detergents are not effective in removing fat from below the surface layers.” This fat reduces the elasticity of the inflations, cuts their efficiency, and results in improper milking. Fatty deposits contain many types of bacteria, some of which may cause mastitis. This can be removed by boiling the rubber parts once a week in a solution of two tablespoons of lye in a gallon of water. Place the inflations in an agate-ware container, cover with the lye solution, and boil them for 15 minutes. Let
them stand until cool, then discard the solution. Wash and rinse the parts and store them in a cool, dry, dark place for a week. Two sets of inflations used every other week and maintained in this manner, aid in control of mastitis, last longer, and milk better.

*Maintain a Clean Vacuum System.* Faulty vacuum systems are responsible for many outbreaks of mastitis. It is imperative that the degree of vacuum be correct for the milking machine used. Excessive or insufficient vacuum causes slow milking and irritation to the teats and the udder.

Vacuum lines clogged with foreign substances are a frequent cause of improper vacuum levels and thus a predisposing factor for mastitis. A vacuum line should be cleaned routinely at least twice a year, and more often if necessary. Occasionally a line is so badly plugged that the only remedy is to take it down and clean it, or better still, to replace it with new pipe of at least one-inch diameter. For barns milking more than 12 cows, one-inch galvanized pipe should be used for vacuum lines.

Fast milking is an important part of proper use of the milking machine (12). In a study at the 114-cow Cornell University dairy herd, the average total time per cow was three minutes and thirty-five seconds. In the report of this study Dr. L. H. Schultz stated that "A good milking procedure is a time saver. It also saves udders and enables the dairyman to get more milk of higher quality."

*Veterinary Service.* Accurate diagnosis and properly selected treatments are next in importance. Treatment by or under the supervision of a veterinarian gives best results. No matter how efficient diagnosis or treatment is, these are frequently of little permanent value because the dairyman fails to protect the cow from reinfection.

**Dipping of Teats in An Antiseptic Solution After Milking.** At the end of the milking operation the end of the teat is slightly dilated and also a small droplet of milk remains on the teat end. Removal of this residual milk may be accomplished by dipping the teat ends in a 200 to 250 parts per million chlorine solution, a two per cent soluble pine oil solution—1 tablespoonful in 1 quart lukewarm water—or in ordinary rubbing alcohol. This simple dipping procedure washes the milk from the end of the teat, acts as a disinfectant, and removes an attraction for flies during the summer months.

**Stall Bed of Adequate Size and Clean.** Teat injuries of any kind make the danger of mastitis infection more imminent. Stalls that are large enough to accommodate the cow, kept clean, and provided with an abundance of bedding, are excellent insurance against injured teats.

*Provide Clean Yards, Lanes, and Pastures.* Paved or properly graded yards, lanes, and pastures—free from mud and trash—aid in keeping teats and udders clean and reduce injury and exposure to bacteria-laden filth.

*Mastitis-free Replacements.* Properly raised first-calf heifers are the safest replacements. Regard all purchased replacements as potentially dangerous. This is particularly true of cows that have milked one or more lactation periods. Examine replacements very carefully for mastitis and other diseases before purchasing. A competent veterinarian should examine replacements for mastitis and all other diseases before purchase.
Any consideration of treatment must be done with the realization that treatment is most effective only when accompanied with adequate preventive measures. In many cases herdsmen equip themselves with huge quantities of mastitis treatments and treat many animals that do not need treatment, or treat them with materials not indicated for the specific type of infection in the udder. This sort of practice often creates a highly aggravated state of mastitis infection and udder troubles. A much safer policy would be for the dairymen to use supportive treatments and avoid invasion of the teat end with a cannular until it is definitely proven to be necessary; then use treatments that are administered by or under the supervision of his veterinarian. Twenty years ago everyone knew that the use of teat (milk) tubes, teat dilators and the like were a sure invitation to serious udder trouble. Today most people have forgotten this danger. They rely on the sense of false security that the antibiotic in the tube will destroy the contaminating organisms as well as the pathogens. It is conceivable that this kind of treatment may in many herds, be doing more harm than good. Practicing veterinarians report that they are having greater difficulty with acute cases of mastitis today than they did a few years ago, for instance, when the new antibiotics first became available. This suggests that highly resistant bacteria capable of causing septicemic reactions as well as local udder inflammation, which are frequently fatal to the cow, are in the cow's udder as a result of careless and promiscuous treatment.

Treatment is receiving a very prominent place in the studies of the New York State Mastitis Control Program and encouraging results are being achieved. A complete and thorough physical examination of the udder and its secretions by a veterinarian provides a fair basis for treatment. This, combined with a repeated laboratory analysis of milk samples from each quarter of the udder, gives a complete and much more satisfactory diagnosis. To obtain the best results from treatment, it is necessary to know the type of infection being combated. For instance, penicillin is usually effective against *Streptococcus agalactiae*, but is not effective against coliform infection. Also, the most favorable results from treatment occur when administered before the mammary gland or its secretions are badly damaged. Mastitis treatments require the technique of a skilled operator and can be most effective when administered by or under the supervision of a veterinarian. Last, but not least, it must be recognized that cows are not made immune to mastitis by udder infusion, and treatment without prevention is of little lasting value.

Bovine mastitis control presents a challenge to the dairy industry and offers an opportunity to reduce costs of producing milk. This helps ease the pain of the "economic squeeze" dairy herd owners are feeling.

"A chain is no stronger than its weakest link." Bovine mastitis is being controlled in many dairy herds in New York State to the point where it is no longer a serious economic problem. In these herds clinical and laboratory diagnosis accompanied with correctly selected treatments administered by or under the supervision of the dairymen's veterinarian, are basic factors of success. But the dairymen who succeeds in the control of mastitis knows that HE AND HE ALONE must insure the success of mastitis control in his herd through good management and sanitation.
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The report of the Committee on Infectious Diseases of Cattle is limited to short considerations of mastitis, leptospirosis, and a group of diseases which for convenience and comparative purposes is designated as the "mucosal disease complex."

The part on mastitis was prepared by I. A. MERCHANT with the aid of R. A. PACKER and L. E. BARNES, Dept. Vet. Hygiene, Iowa State College, Ames, Iowa. The Committee wishes to thank Drs. Packer and Barnes for their aid.

The material on the "mucosal disease complex" and leptospirosis was largely prepared by Chas York.

Where parts of reports are by single persons a freshness of thought and of individual expression is effected.

**MUCOSAL DISEASE COMPLEX**

During the past 8 years there have been an increasing number of reports in scattered areas throughout the country of diseases of cattle in which ulcerations of the oral mucosa are a prominent clinical or pathological sign. The first of these described and the most completely studied is virus diarrhea, reported by Olafson et al. in 1946 (1), with further details of the infection worked out by Olafson and Rickard (2), and Baker et al. (3). This disease is characterized by a diphasic febrile response, leukopenia, excessive salivation, a nasal discharge of stringy material, and ulcers on various parts of the oral mucosa, nostrils and muzzle. Coughing frequently is seen, as well as diarrhea in the later part of the febrile period. Abortions appear to be a common sequel. Punched out ulcers may also be found in the upper portion of the gastro-intestinal tract as well as larynx. Mortality appeared low but incidence of clinical disease in a herd was often high.

A similar type condition was reported in Iowa in 1951 by Ramsey and Chivers (4). Because of the marked amount of mucosal ulceration noted in their cases they named it mucosal disease of cattle. Although the majority of clinical and pathological signs closely resembled those of virus diarrhea, some differences have been noted, especially an apparent high mortality and low incidence. Details of mucosal disease as reported by Ramsey were in last year’s report and will not be repeated here.

A condition similar to mucosal disease, although perhaps different in details, has been examined in Illinois (5), Wisconsin (6), and in Indiana (7). In Indiana a high morbidity and low mortality was usually observed in affected herds. In Wisconsin both general types of disease occurred, that is, there were affected herds where there was high morbidity and low mortality and others with low morbidity and high mortality. In the latter instance the disease was the same among affected animals in the same herd but varied widely between herds so that there was question if one was dealing with a single disease entity or with a group of diseases. To
further complicate the picture a mucosal type disease with a more marked respiratory involvement and of high incidence in affected herds has been observed in California over the past year (8).

Obviously, it is not known at this time whether the various conditions observed are caused by the same or different etiological agents. Epidemiologically they all appear contagious although not always transmissible experimentally. A virus has been demonstrated to be the cause of virus diarrhea and this virus has recently been confirmed as existing in California (9). The Indiana disease has been shown to be transmissible (7) and limited studies indicate it is not related to virus diarrhea. Extensive experimentation by the various investigators is needed, both to isolate the etiological agents and determine the possible relationship between them. Further work is necessary to determine the diversity of clinical disease that these agents may produce, the natural means of transmission and the over all economic importance of such infections. Only then will it be known what control measures are desired.

LEPTOSPIROSIS

Not too much new information has been added to the leptospira picture during the past year, except the recognition that *Leptospira pomona* infection in swine produces abortions or weak pigs. No clear cut clinical manifestations other than the above has been proved to be caused by this organism.

It has been suggested by some that leptospiral infections other than that of *L. pomona* occur in rather wide areas in the cattle population. The leptospira suggested are normally harbored by rodents in other parts of the world. While it must be kept continually in mind that the possibility exists that such organisms may become established in the bovine population, at the time of this report there is only serological evidence that animals may be infected by leptospira normally harbored by rodents other than an occasional *L. canicola* or *L. icterohaemorrhagiae* contact.

Emphasis in control should be placed on the fact that the primary means of transmission still appears to be contact between cattle or swine and cattle. The interpretation of serological results is extremely important in the diagnosis of an outbreak of suspected leptospirosis. The diagnosis of an outbreak of leptospirosis in a herd of cattle or swine, based solely on the demonstration of antibody in low titer in the sera of animals examined, is not justified. The problem still remains for the various states to establish a means of diagnosis of the infection for the veterinarians, based on a realistic serological approach, and to determine the extent of the disease in the various localities. Appropriate means of control could be more easily developed with such information.

BOVINE MASTITIS

Bovine mastitis remains a major problem among cattle diseases and is economically the most important disease of dairy cattle.

A dairy herd without more or less trouble with mastitis is rare indeed. Although considerable research on bovine mastitis in the past few years has resulted in some progress towards its control, such research has revealed additional complexities as well.
Several etiological agents have been added recently to the already long list of organisms known to cause udder infection in the bovine. *Leptospira pomona*, *Cryptococcus neoformans*, *Klebsiella pneumonia*, *Pasteurella multocida*, *Mycobacterium lacticola*, *Diplococcus pneumonia* and a yeast all must be considered as possible organisms in making a bacteriological diagnosis of mastitis. The frequency with which these organisms occur in the udder is probably not great, but each of them has been found capable of causing udder infection in more than one cow in a herd. *Leptospira pomona* and *Crypt. neoformans* have been found to spread in some herds until the infection becomes a herd problem.

The cocci still predominate as the cause of mastitis except in rare instances. Differences in the occurrence of streptococci and staphylococci in various geographical areas of the United States have been noted. In the eastern dairy areas most reports emphasize the importance of *Strep. agalactiae* as the principal cause of mastitis, while in the mid-west and far western states *Staph. aureus* predominates especially in the small farm herds. However, herds are found in eastern states in which *Staph. aureus* is a problem and some larger herds in the western area in which streptococci predominate.

There is evidence that mastitis organisms may "compete" for the bovine udder. It has been noted that following the elimination of *Strep. agalactiae* from dairy herds the incidence of other organisms increases. Furthermore, it has been shown that the injection of *Strep. agalactiae* into a quarter infected with *Staph. aureus* is followed by disappearance of the staphylococci. Although mixed infections are not rare in mastitis, they occur rather infrequently even in herds where four or five different species or organisms are known to exist.

Control measures for bovine mastitis have received considerable attention during the last few years. Sanitation, management and treatment are equally important factors in control and must be coordinated for success. It is apparent that in order to control mastitis constant attention is necessary on the part of the dairyman and his veterinarian. Several practices are coming into general use among progressive dairymen. These include separate cloths for udder cleansing, sanitizing the teat cups of the milking machine between cows, use of strip cup and bromthymol blue tests, milking known infected cows last, prompt treatment of mastitis cases as soon as they are evident and increased use of pen type-milking parlor barns. Such measures properly applied have aided in the prevention and control of mastitis in many herds. Many dairymen have only gone part-way on a control program, expected too much and have been disappointed.

One factor of management that has not received enough attention is the newly-purchased cow. Large numbers of chronically infected animals are offered for sale each year and are introduced into new herds where they continue to spread the disease.

The discovery of antibiotics was heralded by some as the probable end of the bovine mastitis problem. Although some progress has been made in the ten years since penicillin became available, mastitis remains a major disease problem of the dairy cow. The successful treatment of streptococic mastitis with any one of several antibiotics alone or in combination is well established. However, response to the treatment of staphylococccic infections is quite different. Clinical improve-
ment is usually possible in nearly all cases, but eradication of the staphylococci from the infected udder is not accomplished in more than 50 to 60 per cent of the cases. Infections caused by Coryn. pyogenes and Pseudo. aeruginosa are very difficult to treat. Failure of treatment cannot always be explained on the basis of antibiopic resistance on the part of the organisms. In a majority of infections caused by staphylococci and streptococci which do not respond to treatment, the organism is not resistant but failure to respond is due to some other factor. In some instances failure occurs where a member of the coccus group is assumed to be the etiological agent but the infection is actually caused by E. coli, and the drug given is completely ineffective. In still other cases apparent failure results because reinfection occurs shortly after treatment is given.

Mastitis cannot be controlled unless it is attacked as a herd problem and constant attention to sanitation, management, accompanied by intelligent use of treatment procedures. It can never be completely eliminated from herds of any size for very long. It can be held to a very low level, and it has been shown that it is economical to do so. Mastitis will continue to be the most significant disease of the dairy cow unless the above facts are recognized by the dairyman and the veterinarian.

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CIVIL DEFENSE: WHAT IT MEANS AND ENTAILS, BOTH TO THE LIVESTOCK PRODUCER AND CONSUMER

Val Peterson*

Good morning to you, ladies and gentlemen assembled here from all over the United States.

I don't know anything about your business except that while I was Governor we one time had an outbreak here, very suddenly and very seriously, of what I believe you call vesicular exanthema. I never knew for sure at the time whether we were operating properly or not, but we called a special session of the legislature and we appropriated half a million dollars, and we eliminated vesicular exanthema from Nebraska within a matter of a couple of weeks.

It worried me, I must confess, for quite some time, and I wondered whether we had perhaps moved too fast. [Laughter] Someone told me this morning that we had moved just right, and that indicates to you that sometimes you are right when you are in public office, but frequently you don't know whether you are right. At any rate, we moved on it.

This morning I would like to do three things in visiting with you. I would like to tell you of the problem we face in the United States that requires that we have such a thing as civil defense; secondly, the effects that may be expected upon you and me as individuals; third, some comments with respect to your professional interest in the well-being of animals in the United States and in the world.

The Russians have the capability of attacking the United States at the present time with atomic weapons should they see fit to do so. They could deliver those weapons either from submarines or from airplanes flying over the United States, and it is entirely possible that some of them could be carried into the United States in suitcases, which of course would be a very dangerous thing for them to undertake, because if we caught the first one it would tip off the entire world what they were up to. But the threat is there.

That threat will grow with the passage of time. One, two, three years from now they will have more and better airplanes, and they will have bigger and more bombs. Whether they will see fit to attack the United States or not is a matter you can decide for yourself, dependent upon how much knowledge you have of their activities in recent years, and dependent upon your feelings as to the things that motivate them.

It is not my job to prophesy whether there will be war or not, but it is my job to point out that when a potential enemy has the ability to attack the United States, we must do certain things as prudence dictates.

If an attack comes upon the United States, the job of preventing the bombs from falling or being placed in the United States is the responsibility of our military. I can tell you that our military is doing everything it is humanly possible to do to protect the United States against such an eventuality. I think they are doing a very fine job in a very difficult field.

Civil defense's job is to minimize the effects of the attack, both by action taken

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immediately preceding the attack and by action taken immediately following the attack.

There are two broad things that civil defense can do. In the pre-attack period it has only one weapon or one tool that it can employ, and that is the utilization of space. If the enemy bombers are coming toward the United States, in view of the size of present-day bombs, there is only one thing for us to do if we want to be alive after the bombs have fallen, and that is to not be where the bombs are dropped. That's all there is to it.

In World War II it as possible for the people in London and in Berlin and in the other great German and English cities to keep on working and to keep on living in the cities, and to absorb at the same time the block-busters that were rained down upon those cities. As a matter of fact, if a block-buster were dropped on the Fontenelle Hotel and it hit on one corner of the hotel, maybe this meeting could continue, even though we might be jarred up somewhat. In other words, those block-busters, while they are bad—and I would not minimize any bomb—simply do not bring the destruction that the bombs have which we are up against today.

Today we are up against bombs that are continually increasing in their destructive ability. The weapon that was exploded at Eniwetok in November 1952 was in the megaton range—millions of tons of TNT explosive equivalent.

When that bomb went off, if you will remember, it blew a hole in the surface of the earth 175 feet deep, and big enough to put fourteen Pentagon buildings in it.

That was a small bomb in view of what may come in the future in this field. We may not be in a situation, if and when a third world war should eventuate, where we will have bombs of 10 or 15 megatons, or 25 or 50 or maybe more. Nobody knows exactly where the end is in sight.

If a bomb of that type should be dropped upon a city the size of Washington, D. C. for instance, it would obliterate the city, it would fractionalize the buildings, vaporize them, pulverize them and throw them up into the air in dust.

When you face the possibility of an attack of that kind you can't talk about remaining within the cities. You can't talk about "duck and take cover"; you can't talk about staying at your lathe as the Germans did in World War II. It made sense for them to stay. As a matter of fact, the Germans increased their productivity even under American and English bombing for many, many months. That was possible under the threat of a block-buster.

But when you talk about atomic bombs or hydrogen bombs, anyone talking about standing on the corner and baring his breast to the bomb in a great burst of patriotism is simply asking to be passed on to the next world in a very odd form. I don't know what form it would be, but it would be a quick way to get there.

What can we do about it civil defense-wise? Well, we are now constructing in the world a detection system that will give us warning time, a detection system that will extend all the way from Hawaii over the wastelands of Alaska and Canada to Iceland and Greenland, and with an arm sticking down to the Azores, made up of ships at sea carrying radar equipment, and airplanes flying with radar equipment off the shores of the United States, and with fixed land installations in the northlands of Canada and Alaska and those other countries. This thing must be in depth.

When that detection system is in, and we are going forward with it as rapidly as
we can, it would be foolish to prophesy the day it will be done, because we are working under the most difficult conditions of terrain that man has ever encountered in the northlands of those countries; when it is completed, we will have from four to eight hours of warning time of an impending enemy attack. As the attacking planes come into this screen, our Air Defense Command detect them and then we will warn the people of America, "Get out of the cities."

I started talking about evacuating these cities about a year ago last June. A good many people thought that possibly I was a bit touched in the head, and they said, "You can't evacuate an American city. Think of the terrible traffic snarls we have at 8 a.m. and 5 p.m."

There is a lot of truth in that, because I drive in those traffic snarls in Washington, too, and they are bad. However, there has now been a series of experiments in the United States. The first one was in Spokane, Washington. In Spokane, a city of 175,000 people, one Saturday morning in the rain they moved all of the people on foot out of the downtown office and industrial buildings seven or eight blocks on foot to a place where they would have loaded them in cars. There were 16,000 people, and they were moved in 8½ minutes.

In Mobile, Alabama, with over 200,000 people, they moved all the people out of the downtown area in automobiles—an area of over 400 blocks—and they moved 30,000 people to the edge of town in 22 minutes.

In Houston they moved all of the automobiles out of a downtown area and put the people on the streets in the buildings in six minutes.

We have just concluded a study in Milwaukee that we will announce to the press and will release to the American people and the people of the world by the end of this month, made by the best traffic engineers and control specialists in America. It showed that we can save hundreds of thousands of lives in metropolitan Milwaukee with two hours of warning time by moving them out of the city, and several hundred thousand in three hours. We can continue studies of this kind.

However, I point out to you that in the Chicago Loop there is a daytime peak population of 900,000 people. At night there are only 85,000 people. We evacuate Chicago and New York and all these big cities every day. Actually, if you have one-way traffic and controlled traffic, you can move people out much more rapidly than you can move them in or out in the daytime when there is all this cross traffic.

We have to have a detection system, the warning time, and then we must utilize space by moving out on the surface of the earth. There are only two ways you can utilize space—either by digging down deep in it to escape the bomb, and that is impossible at the center of the bomb burst, as I pointed out to you, because it will make a hole 175 to 200 feet deep, but nevertheless shelter is still very valuable; or, you can move out on the surface of the earth. It appears to me it would be much less expensive and more sensible to move out on the surface of the earth.

If an atomic bomb is exploded you get three broad reactions or effects. First, there is the blast effect. The blast effect is simply the creation of a pressure per square inch on a building such as this, of such intensity that you fractionalize the building. It blows to pieces. The radius of total destruction will depend upon the size of the weapon and the point at which it is detonated.

If you detonate the bomb high in the air you don't get quite the same pressure
effect on the earth. So, it appears now that with these tremendously big weapons they may be detonated into the ground or at the ground. Then, of course, we get a tremendous blast effect, not over quite as wide an area, but because of the size of the bomb you get all that you want up to three, four, five, six or seven miles, depending upon the size of the weapon. That is a radius of total destruction.

Then you have another radius of severe destruction, one of moderate destruction, and one of light destruction.

The second effect that you get is a thermal effect, a heat wave, that moves with the speed of light. It is instantaneous. That wave will go over a number of miles, depending again upon the size of the weapon and the atmospheric conditions.

The only thing I know of that the Los Angeles smog would be good for would be to cut down the thermal wave if there were going to be an explosion over Los Angeles. I don't believe it would be quite good enough even under those circumstances. It would cut the wave down. The number of miles that that thermal wave goes effectively is dependent upon the dust in the air and moisture in the air, and that sort of thing.

I won't take time to talk about those two this morning because I want to talk about where we are going to need your help, and where we are going to need the best thinking in America in this particular field. I want to talk a bit about the problem of radioactivity.

We have always known that when you explode atomic weapons you are going to have radioactivity, but I am sorry to say that we underestimated somewhat the importance of radioactivity because we were thinking in terms of bombs that would be exploded high in the air. If you explode a bomb 2,000 feet in the air you don't get all the debris thrown up into the air that you get if you explode a bomb closer to the ground or into the ground.

When a bomb is exploded you get three effects, radioactively speaking. First there is a puff-out. As the bomb goes off it blows radioactivity out for a certain number of miles, depending upon the size of the bomb. Then the surface winds come into play. The winds from zero up to 10,000 feet or one foot up to 10,000 feet are not so important in this problem, although they do have some importance. They will move some of this radioactive material around the countryside. But the real problem is that the winds that really control are the winds from 10,000 to 50,000 feet.

If you will remember the explosion that we portrayed in Operation Ivy, this material that was thrown into the air was thrown up 40,000 to 60,000 feet. That is ten miles or more. The heavy particles fall out relatively fast. The lighter particles remain up in the air for quite a long time in the atmosphere.

The surface of the upper winds, the controlling winds from 10,000 to 50,000 feet, start moving this mass of material across the countryside, and what goes up has to filter back down. Where it will come down is dependent, of course, upon the velocity of the wind and the size of the particles and the size of the weapon, and how much stuff is thrown up.

In this country and, in fact, all around the world, the prevailing winds from 10,000 to 50,000 feet are usually from the west, practically exclusively from the west. Those winds are blowing around the earth west to east all the time, with some variation between summer and winter between southwest and northwest. This means that if
we are evacuating a city and moving people out, we would not want to move them downwind because we would move them into another zone of danger. And so we would want to move them upwind or in some other direction so that they would escape this fall-out area.

We have a lot to learn yet about this fall-out—the exact pattern of it and the dosages of it. I am not privileged to talk to you about the pattern or the dosages because that is a highly classified matter at the present time, for reasons that are perfectly good. We don't know how much the Russians know about these things, and there is no point in giving them any comfort or information. They have been getting too much of that in various ways already. They have plenty of good scientists of their own. At any rate, we know that there are a certain number of degrees of the circle that this stuff falls out in ordinarily, on the basis of the information we have at the present time.

This does not pose a hopeless problem for civil defense or for the American people or for the people of the world. It makes the problem more difficult. In addition to this business of escaping the effects of the blast and the fire, now we have to worry about protecting ourselves against radioactivity. Something that comes out of the sky, that you can't see or feel or smell or taste, can mean death for you certainly, or serious injury, depending upon the dosage you get and the number of roentgens you get.

One relatively good thing about this—and everything is relative in this world that we live in, particularly in this day and age, it seems—but at any rate one thing that is relatively good about it is that this radioactive material decays pretty rapidly. As a matter of fact, in many instances it decays in a matter of hours, and it is hardly conceivable that anyone would be immobilized for more than a couple of days.

There is a rather easy method of protecting yourself against the effects of radioactivity. If you are inside a building like this, you immediately cut the effects of radioactivity a certain percentage. If you go down into your basement you cut it materially more; but if you go into an outside cave or something of the type of the old fashioned cyclone cellars that we had in Nebraska and Kansas and in the Middle West area, they are still good as protection against cyclones, and that is one phase of my line of business, because I am responsible for coordinating all federal governmental activities in the relief of natural disaster such as fire, earthquakes, tornados and everything else that occurs in that field.

If you have one of these cyclone cellars or an old fashioned root cave in the back yard with about three feet of dirt over your head, you have practically absolute protection against the effects of radioactivity.

Obviously the door should be built in such a way that you don't have a thin wooden door that the radioactive material can penetrate. You want three feet of dirt entirely over the cave. That is simply a matter of building your entrance into the cave. Then you should have some type of filter in the intake, any kind of porous material that will take the dust out of the air, and you will then be in perfectly good shape.

I have said that if you want to survive in one of those caves, about all I can see you really need when you go into it is a jug of water, the equivalent of some cheese and crackers, and some kind of sanitary facility.
You can survive. It is not impossible to survive. It is not too expensive to have this kind of installation. It can be done; in fact, it will now have to be done, not only in America but in all other countries of the world.

I am sure you see the implications of this in your field of activity. I have been talking about your problem as citizens of the United States and as individuals because I know that when I outlined it broadly you immediately saw the implications in your own field.

I heard the Home Secretary of Canada one day, on a program on which he and I both appeared in Windsor, before the Canadian Municipal Association, and I doubt very much if many who heard him understood him. He said, "I doubt there are any further targets in Canada. Canada herself is a target."

I am sure you understand what he meant. From now on these atomic attacks are not going to be alone on the wicked people who live in our cities, but from now on the attacks can very well be upon any farmer or rancher living in any small town in the United States.

This means, of course, that these effects of atomic attack will have an effect upon the livestock population of our homeland and also the poultry population and all the domestic farm animals and also the wildlife of the United States.

When you start talking about protecting cattle against the effects of radiological fall-out by putting them in caves, you are getting into something that is much more complex and difficult than this business of putting human beings in a cave. Getting human beings in the shelter is certainly not an impossibility at all in this country, in terms of money or effort or anything else.

I should have said earlier that you should stay in the cave until your Geiger counter (if you have one) indicates it is safe to come out, or until somebody comes to you and says it is safe to come out, or until you hear it over the radio, a battery type radio which you should have with you in the cave.

There are many things you can do to protect yourself against radioactivity. You can wash it off your body, you can wash it off your house if you have a sprinkler, but I wouldn’t want to be where it goes into the cesspool or the creek, because there will be a big dose of radioactivity there.

We need your help. When I say "we" I mean civil defense at the national and the state and the city levels, and I mean the Department of Agriculture, which has the responsibility in the federal government for working out measures to meet this problem, because my agency delegates this responsibility to the other departments of the government—health, education and welfare, the Department of Agriculture, and all around the entire governmental organization. We have to figure out some way to protect the cattle population of this country, because we certainly can’t exist in this country (assuming one of these attacks upon the United States is successful) if a large portion of the animal population is destroyed or infected.

Again, I don’t think this problem is impossible, although again I admit it is a very difficult problem.

More than that, we believe that should there be an attack upon the United States, the communists in Russia would also use and introduce planned animal diseases in this country. Certainly the people in the Department of Agriculture, the people in our great agricultural colleges, and you people who are in this business profes-
sionally, have a responsibility to be thinking now about the things that we will have to do in the United States if we begin to find strange diseases breaking out on our farms in our animal and poultry population. As a matter of fact, we also will have to be thinking about the introduction of plant diseases into the United States.

It would seem to me that if a third World War starts, and heaven forbid it ever does start, but if it did start we could very well have the employment by the enemy not alone of atomic warfare, fissure fusion warfare, but we might have the employment of gas in some form or other. We might have the introduction of biological warfare. We certainly will have psychological warfare, and we may have shells thrown into our country carrying atomic warheads from submarines. In other words, we may get the entire book thrown at us. Certainly I would be the last one to feel that the Russians or the communists (and I use the term as synonymous at the present time) would hesitate to use any of these things upon us in our country.

I would like to conclude on an affirmative note and not simply be affirmative, but because I utterly believe this: We as Americans should not be neurotic about this business of the Atomic Age. We should not live in constant fear of a possible World War III. Please bear in mind that we are the most powerful nation in the world by any test that you want to apply, and it is not a simple task for the Russians to attack the United States.

While it is true that they could attack us today, while it is true that bombers will get through, while it is true they have a greater ability six months or a year from now, it is also true that if they attack the United States they will pay a frightful price in the process of the attack.

We will shoot down tremendous numbers of those bombers. There will be a fearful attrition, and the moment they start that attack against the United States the Strategic Air Command, under the command of General LeMay of this very city will be on its way to rain destruction upon Russia.

At the present time we have a better Air Force, a bigger Air Force, and more atomic weapons than they have. If they open up this kind of engagement, while it means catastrophe for the entire world, they are the people who will have to be fearful of the consequences, and accordingly they are not going to start World War III, in my judgment, for any light or transient causes.

In other words, they may never start it. There is a possibility that the world can escape this cataclysm. But please bear in mind, too, that if they attack they can attack only a limited number of American cities.

But suppose the attack the seventy greatest metropolitan complexes in America, including St. Paul-Minneapolis, Omaha-Council Bluffs, Newark-New York, Brooklyn, and those cities. If they attack those seventy metropolitan leading complexes, they attack 70 million Americans—about 92 cities. I don’t think they have any such capability or will have it for a long time, because they have to attack the Strategic Air Command simultaneously, because they don’t want that retaliation to occur.

There is no use making the enemy any bigger or more powerful than he is. We don’t want to underestimate or overestimate him. We don’t want to be Pollyannas or long-faced pessimists about this, but if they were to attack those ninety-two cities they would attack only 3 per cent of the real estate of America. I know of no
bombs in existence nor contemplated that could blow up the entire United States or any great part of the United States.

I know of no weapons in existence that could destroy the United States or the whole world. Sure, somebody could make a cobalt bomb, but if he makes a cobalt bomb and if he fires that cobalt bomb, with those prevailing winds going around and around the world, all he is doing is signing his own suicide order, because while he may kill the enemy, the fearful death he has created on the enemy will some day roll around on top of him, and that will be the end of him. The reason is that the cobalt element has a long half-life, and it will just drift around the world bringing death and destruction.

I deal with catastrophe all the time, both peacetime catastrophe and atomic catastrophe. I still sleep eight hours every night, and I still eat every meal I get a chance to eat. There are many things to live for. There are big reasons for being optimistic. We may have peace in our time. We may be smart enough to stop this business of slaughter fests every twenty-five years. We may be able to chain the atom and make it work in peacetime for the benefit of mankind.

Let's look at this thing from a hopeful standpoint. Let's not be stampeded. Let's not be neurotic or fearful. But let's prepare. Let's use common sense in getting America safe and keeping her safe. [Applause]
THE PROBLEM OF BLUETONGUE CONTROL IN RANGE SHEEP

D. A. Price, D.V.M.*

Sonora, Texas

The presence of bluetongue in the United States was first suggested by a report in 1952 (1). Somehow, a mild form of this "foreign" disease unobtrusively established itself in our country and escaped recognition as a disease entity for many years. In the wake of positive identification, there quickly followed the retrospective presumption of its prior existence. Ranchmen and veterinarians alike assert that a clinically similar condition has been seen for more than two decades in Texas. Recently, our communications with other research workers and livestock sanitary officials indicate that bluetongue exists in many states other than California and Texas. At the time of this writing, some correspondence with the Chief of the Agricultural Research Service's Animal Disease Eradication Branch indicates that laboratory confirmation supports the diagnosis of bluetongue in Arizona, Colorado, California, and Texas, and that clinical diagnoses have been made in Kansas, Oklahoma, Nebraska, New Mexico, and Utah.

The recent and rapid progress toward the control of bluetongue in the United States was in large part due to the very excellent South African work. The disease there came under observation even before the turn of the century and has subsequently been controlled through the use of a quadrivalent avianized vaccine. Although more than ten strains of the virus exist in that country, a considerable amount of cross-protection occurs, so that four modified strains incorporated in a vaccine afford adequate protection against all of their known virulent strains.

USE OF VACCINE IN THE UNITED STATES

Within the past two years, avianized bluetongue vaccines were developed independently at the University of California and at the Texas Station. The California vaccine contained two isolates designated BT-8 and BT-11. The Texas vaccine was made from one isolate called Sonora. The commercial producers of bluetongue vaccine have used only the California virus, but since recent studies (2,3) have shown all known isolates in the United States to be immunologically similar and perhaps identical, and since the clinical disease has been more severe in California than in Texas, this univalent California-strain vaccine may be satisfactory. However, the occasional appearance in Texas of infected sheep showing evidence of two distinct zones of coronitis in the hoof substance indicates the existence of antigenically dissimilar strains. If the California-strain vaccine does not provide a basal immunity sufficient to protect against all of these strains, then a multivalent vaccine will have to be developed.

Unfortunately, the problem of bluetongue control was not solved by the production of avianized vaccine. The vaccine has been marketed for about five months at this writing, but no one has determined the minimal age at which lambs can be

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vaccinated; nor is anyone prepared to specify the duration of immunity following vaccination.

But even when such questions have been answered, complete and satisfactory control of the disease is still unlikely to be obtained through vaccination. The vaccine per se promises to be an excellent product, but we have already noted considerable reluctance to purchase it on the part of sheep growers. The cost of vaccinating and the very low mortality rates in some states are important factors to be considered where range sheep are concerned. For these and other reasons, many ranchmen may not vaccinate with regularity; rather, they will tend to await the appearance of epizootics or outbreaks. Finally, it is interesting to note that even in South Africa, where mortality rates are high and where vaccine is furnished by the government on a cost basis, the tendency not to vaccinate during non-epizootic years remains an unsolved problem.

RELATIONSHIP OF BLUETONGUE TO RANGE STIFFNESS

The disease condition called "range stiffness" in the southwest affects lambs which are mainly in the three- to eight-month age group. They become stiff or lame in one or more limbs, are inappetant, lose considerable weight, and sometimes die if large pastures make it necessary for them to travel very far for water. Gross pathology usually consists of peripheral pulmonary consolidation or pneumonia. This condition, like frank bluetongue, has existed for many years in the United States, but only since bluetongue was recognized as a disease entity has the relationship between the two conditions become clear. Dr. W. T. Hardy, Superintendent of our Substation, recently reported to a legislative research group that the annual loss in Texas due to the range stiffness form of bluetongue is probably one-half to one million dollars. Investigations are now being planned to determine if the avianized vaccine can be used to protect against this form of the disease.

To explain the relationship between range stiffness and bluetongue, it is necessary to relate some facts about bluetongue immunity which were passed on to us by Dr. R. A. Alexander of the Union of South Africa during his visit to this country in 1953. As a result of natural infection, mature sheep are considered to develop life-long immunity to that strain. In the case of ewes, they will thereafter provide antibodies in theircolostrum and their lambs will thus benefit from a transient passive immunity. This passive immunity will be at its height shortly after the initial suckling and will gradually decrease, often disappearing by the fourth month; its protective value is directly proportional to the immunity of the dam.

It is theorized that lambs are often infected at a time when their passive immunity has not yet disappeared but is still strong enough to prevent the development of frank bluetongue; the resulting clinical disease is called range stiffness. Furthermore, observations made in the field suggest that no active immunity results from these mild infections, the lambs being fully susceptible later on. On the other hand, both South and East African workers state that suckling lambs cannot be vaccinated successfully, and if this proves to be the case in the United States, then our sheep industry is slated to suffer considerable annual economic loss due to mild bluetongue or range stiffness, unless another means of control can be provided.
A possible solution to the control of the range stiffness syndrome or mild blue-tongue in lambs may lie in the use of insecticidal or insect-repelling sprays. If flocks were sprayed monthly (or perhaps more often, depending upon the residual activity of the ingredients) during the time the lambs are from three to seven or eight months of age, it might be possible to thereby control the vector until the lambs have reached an age where vaccination would surely be successful. As a matter of fact, this plan for providing temporary protection appears to have been effective in one of our own flocks and in at least one other.

**VECTORS OF BLUETONGUE**

It was reported from our laboratory that *Culicoides variipennis* is a vector of bluetongue in Texas (4). This was in confirmation of the work in South Africa, where no vector other than the Culicoides midge has been reported.

During the late spring of 1954, mosquitoes were suspected of causing an isolated outbreak of bluetongue in a pasture on our Station. The predominating species (later identified as *Psorophora cyanescens* by Drs. Richard H. Foote and Alan Stone of the Agricultural Research Service's Entomology Research Branch) in the outbreak pasture at that time was selected for limited investigation, and in this connection the valuable assistance of Mr. O. C. Schomberg of the Entomology Research Branch at Kerrville, Texas, is gratefully acknowledged. Adult female specimens were caught in the wild state and a total of sixty were allowed to feed on a sheep previously inoculated with the Sonora strain of bluetongue virus. These engorged specimens were then divided into several groups for subsequent feeding on fully susceptible sheep on several successive days. Omitting details, it will suffice here to say that these specimens failed to transmit the disease under these conditions; however, on the sixth day after the initial feeding, the surviving mosquitoes were emulsified and inoculated intravenously into a fully susceptible sheep. Mild clinical bluetongue appeared after nine days' incubation period.

A communication from Dr. James R. Douglas of the University of California informs that he and Doctor Glenn Spurlock of that state conducted some trials with wild-caught *Aedes nigromaculis*, a mosquito species found in abundance in some of the California outbreak pastures. While emphasizing that their work should be considered only tentative, they indicate that there was some evidence that bluetongue virus is maintained for at least two weeks in this species.

Those who would rise to the defense of mosquitoes against a charge of bluetongue vection will find comfort in the knowledge that cross-immunity studies in South Africa and at Sonora have been conducted with sheep in open stables without known accidental infections occurring. This, despite the fact that although Culicoides tend not to enter buildings unless attracted by lights, many mosquito species would find it much to their liking.

At any rate, the limited work with suspected vectors does cast suspicion on mosquitoes and points up the very real need for an entomological team to study the life cycle and habits of Culicoides. Here is a chapter in medical entomology which is yet to be written.
BLUETONGUE CONTROL IN RANGE SHEEP

VALUE OF QUARANTINE MEASURES

The value of quarantine measures would seem doubtful at best, in view of the foregoing considerations. General quarantine measures against sheep alone cannot be expected to restrict the activities or movements of unknown domestic carrier-animal species, reservoirs in the wild animal population, or the insect vectors. Even partially effective and acceptable quarantine measures would have to include stipulations with respect to other domestic animals (e.g., cattle are known to be carriers in South Africa), vaccinated sheep, and perhaps sheep which had been recently sprayed.

SUMMARY

It may eventually be necessary to add one or more strains to the univalent avianized bluetongue vaccine now being produced and marketed; nevertheless, such a vaccine is potentially capable of preventing epizootics. Where the disease is mild, though, it can be anticipated that the sheep growers will not vaccinate their flocks with enough regularity to prevent an occasional epizootic.

Bluetongue in lambs which have a transient passive immunity is very mild and is manifested as the condition called range stiffness. It bears only slight resemblance to frank bluetongue but does occasion considerable economic loss each year.

Although only a limited amount of work has been directed toward the entomological aspects of bluetongue control, the Culicoides midge has been incriminated and suspicion has been cast on mosquitoes. Until definite information is available regarding the minimal age at which partially immune lambs can be successfully vaccinated, the author proposes to use repellant or insecticidal sprays as a means of protecting them against insect vectors during the four- to five-month period when they are most susceptible to the range stiffness form of the disease.

Quarantine measures would seem to have little merit if directed entirely toward restricting the movement of sheep. In order to give fair promise of effectiveness and still be acceptable to the livestock industry, they should also restrict the movement of possible carriers such as cattle, and make special provision for vaccinated or sprayed sheep.

REFERENCES CITED

VIRUS AND VIRUS-LIKE CATTLE DISEASE ENTITIES NEW TO CALIFORNIA


Davis, California

In October of 1953 an acute febrile condition of cattle characterized clinically by influenza-like symptoms was reported from Los Angeles county where it eventually assumed epizootic proportions. On several subsequent occasions this syndrome made its appearance in various other parts of the state but on a much less extensive scale.

Although possessing certain resemblances to a number of recognized cattle disease entities, the clinical and pathological features of this condition fail to identify it with any one disease syndrome thus far described, or with any condition which has occurred hitherto in California in the memory of either stockmen or resident veterinarians. It has, therefore, been concluded that it is either an exotic or a new disease entity, or that it is a native disease which has become so clinically modified as to be unrecognized as such. In view of accounts of apparently new disease entities of cattle in various other states and inasmuch as this disease has not been hitherto reported on except at the local level, (1) it would seem appropriate at this time to present, as a matter of record, a brief review of the clinical and pathological features of the condition and a preliminary account of the investigational work that has been conducted thus far.

INCIDENCE

The disease has been observed in both dairy and beef type animals. The incidence appears to be higher in mature cattle although calves from four to eight months of age are also affected but less severely. Calves under four months of age are seemingly either refractory or the disease manifests itself in these in a clinically different form. Cows in the first or second lactation appear to be more frequently affected than older animals. There is no indication of any relationship between sex of the animal and susceptibility since the disease occurs in steers as well as in female stock. Thus far recurrence of the syndrome in recovered animals has not been reported.

DISTRIBUTION

The disease was first reported from Lancaster, California. It next appeared some five weeks later in the Los Angeles area from which it spread to various districts in Los Angeles, San Bernardino and Orange counties. In this particular epizootic the last outbreak occurred in early February in San Bernardino county. In the meantime, the condition broke out in a large dairy herd on a state institution farm at Stockton, some 350 miles to the north. On this farm almost half of the cases were

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in calves from four to eight months of age. By the middle of February the disease had run its course. It did not reappear until early the next September at which time it broke out some 20 miles from Stockton in a feed lot containing approximately 10,000 fat steers, the majority of which were Herefords. Some of these animals had been obtained from out-of-state while the remainder were procured from various areas of California. Concurrent with this outbreak another was reported under similar circumstances in a feed lot in Imperial Valley of California. The last one reported occurred in the Los Angeles area but did not involve districts previously implicated. Unfortunately, very few details of these last two outbreaks are available at the present time.

EPIDEMIOLOGY

The epidemiology of this disease presents a number of rather unusual features. The outbreaks thus far encountered have been confined to areas where the cattle population is dense, as in certain areas in the southern part of California, and to large individual groups of animals in districts where dairying or cattle raising is not extensively practiced. Insofar as can be determined, no outbreaks occurred in small herds in the latter type of district. The rapid spread of the disease from herd to herd in areas where the cattle population is great would suggest that it is highly contagious. However, sporadic outbreaks have also occurred in single herds in close proximity to others within affected areas, and in herds at widely separated points to which no additions had been made, and with which no direct or indirect contacts were known to have occurred with either actively affected or recovered cattle.

SYMPTOMS AND COURSE

The first indication of illness is manifested by profuse salivation with the saliva hanging from the mouth in strings, and by a slight serous nasal discharge which, after several days, becomes more copious and of a muco-purulent nature. In milking cows these symptoms are accompanied by an abrupt cessation of milk flow. The temperature in all cases ranges initially from 105°F to 106°F, although readings as high as 108°F have been recorded. At this time the breathing is usually shallow and rapid, and auscultation reveals a slightly increased vesicular murmur. Sporadic coughing of a soft throaty nature is occasionally noted, and the nasal mucosa is invariably deeply congested. Affected animals display a certain amount of depression and anorexia, depending on the severity of the case. From 36 to 48 hours following the initial fever the temperature subsides and remains usually between 103°F. and 104°F. for a variable period of time. In no instance has ulceration of the mucous membranes of the mouth or of the respiratory tract been observed in the living subject by clinical examination. Diarrhea has rarely if ever been noted while determinations made at various stages of the disease disclose that the white blood count (WBC) remains fairly constant and well within the normal range.

Absolute uniformity of symptoms is not a characteristic of the disease as lameness in the rear limbs and conjunctivitis have been observed. The lameness is not accompanied by any signs referable to primary nervous involvement. Reflex or voluntary muscle control is seemingly unimpaired as incontinence is not observed and the reflexes appear to be normal. The ocular involvement is more prevalent
among calves under eight months of age although the occasional mature animal exhibits a very mild type of conjunctivitis. The conjunctivae become deeply congested and a thin, serous discharge then appears which becomes muco-purulent after several days. Corneal opacity has not been observed, the infection apparently being confined to the conjunctivae.

The majority of affected animals make a rapid, uneventful recovery within one week or ten days with little loss in condition. However, a small proportion of cases are characterized by progressive debilitation and marked loss of condition, and by pronounced dyspnea, chiefly expiratory in nature. Occasionally a subcutaneous emphysema develops in such animals, particularly behind the withers, over the lumbar region and along the posterior part of the thighs. Most of the animals that progress to this stage either succumb or are slaughtered. The morbidity varies from five to fifty per cent or even higher in some outbreaks. The mortality is relatively low however, being in the neighborhood of five to ten per cent of the affected animals.

GROSS PATHOLOGY

The principle lesions are limited to the nasal cavity, larynx, and trachea, and end abruptly in the major bronchi. However, the pathology varies considerably, depending upon the severity of the disease. One case which had recovered from the disease prior to autopsy showed no lesions. The respiratory tracts of the less severe cases were reddened and showed scattered petechial hemorrhages. Seromucinous exudate, often slightly foamy, is frequently observed in the trachea. The respiratory mucosa in the severely affected and fatal cases is swollen, congested, studded with small hemorrhages, and covered with a creamy-white, fluffy, loose croupous membrane which can be peeled away, leaving either intact epithelium or a raw surface denuded of epithelium. The nasal and epiglottal mucous membranes in two cases exhibited small, white, unbilicate nodules. With the exception of mild interstitial emphysema in two cases, the lungs examined were grossly normal. The lymph nodes adjoining the respiratory tract are frequently swollen, reddened, and edematous. The only instance of joint involvement which was observed at autopsy was found in a case which showed flexion of the fetlocks. These joints showed excess although normal appearing synovial fluid but no other pathology.

HISTOPATHOLOGY

Tissues for sectioning were fixed in ten per cent formalin and stained with hematoxylin and eosin, Pollack's trichrome, and Giemsa stains.

The mild cases showed excessive activity of the goblet cells in the surface epithelium and in the glands of the respiratory tract. Edema of the mucosa with emigration of neutrophiles through the epithelium was observed. Aggregation of mononuclear cells around the submucosal glands and abscessation and eruption of solitary lymph follicles were observed.

The respiratory tracts of the severely affected cases were covered by fibrinous pseudomembranes which were densely infiltrated with neutrophiles. Epithelium was denuded at points of attachment of this membrane. Dense submucosal exudate composed largely of mononuclear cells, severe hyperemia and focal necrosis of the
mucosa were observed. The only other finding of significance was mononuclear cell cuffing of small blood vessels lateral to the aqueduct of Sylvius in one case.

**EXPERIMENTAL**

**Transmission Studies**

McIntyre (1) reported the transmission of the typical clinical and pathological syndrome to calves by the inoculation of various combinations of blood, nasal discharge, and feces, and apparently by contact. However, this work was conducted in an affected area at the height of the epizootic using calves from that particular area. It was considered advisable, therefore, to attempt to duplicate these results in calves in an area free of the disease in order to exclude the possibility of natural infection. Also, it was considered of prime importance to identify the infectious material or materials from naturally occurring cases of the disease so that etiological studies could be conducted on a rational basis. Transmission studies were, therefore, undertaken at the School of Veterinary Medicine at Davis.

The febrile nature of the condition and the apparent respiratory tract involvement suggested that the blood and nasal discharges might be infectious at some or all stages of the disease. Accordingly, a number of attempts were made to transmit an etiological agent from these materials to cattle. Blood and spleen from advanced cases of the disease were inoculated into two yearling Herefords, the blood being given intravenously and the spleen suspension by the subcutaneous route. Twice daily temperature recordings and daily WBC counts remained within usual limits while the animals presented a clinically normal appearance.

Inasmuch as Ramsey (2) was apparently able to transmit mucosal disease by transfusing large amounts of febrile blood, this procedure was followed in the subsequent transmission attempt. Two animals from eight to ten months of age were each given approximately one-half liter of blood from early cases of the disease. Again, the WBC and the thermal response remained unchanged while the clinical appearance of the animals did not deviate from the normal. In the third transmission attempt freshly drawn blood from early febrile cases of the disease was inoculated both intramuscularly and subcutaneously into three animals, two of which were 12 to 18 month old Holstein steers while the third was a four month old Hereford steer. As in the previous two attempts no departure from the normal in either temperature or WBC count, or in the clinical appearance of these animals could be detected. Blood was drawn on the eighth day following inoculation from each animal and a portion of the pooled sample was then injected intravenously into a two month old Holstein heifer calf. Apart from a transient fever (104.2°F.) which was recorded on the ninth day following inoculation, this animal remained clinically normal. The final attempt to transmit the infection utilized nasal and tracheal curettings which were obtained from two field cases of the disease, one of which was sacrificed during the early febrile stage and the other shortly following the febrile peak. A suspension of this material was instilled nasally into each of three, 6 to 8-month old Guernsey calves, and into the Hereford steer which had been used in the previous trial. A fifth animal was given a portion of the material, which had been treated with antibiotics, by the intravenous route. The nasal tract
of each animal was scarified by means of a stiff-bristled test tube brush just prior to the inoculations. Temperatures were recorded twice daily and WBC counts were made at daily intervals over a period of 14 days subsequent to inoculation. The injected animals remained clinically normal and the WBC counts stayed at approximately the preinoculation levels. However, mild temperature reactions were recorded in the case of one of the intranasally inoculated subjects between the ninth and twelfth day following inoculation while the temperature of the Hereford steer rose sharply to 106.6°F. on the ninth day postinoculation. It regressed within 12 hours but did not drop below 104.0°F. for the next two days.

**Etiological Studies**

Numerous attempts were made to isolate a causative agent from nasal exudate and washings, and from the lungs of affected cattle by inoculating 10–12 gram mice intranasally with these materials. In each case serial blind transfers were made for a minimum of three passages. In addition, blind passage inoculations of spleen from acutely affected animals were made in suckling mice by the intraperitoneal route. Chicken embryos were inoculated by the allantoic, amniotic, and yolk sac routes and on the chorioallantois with nasal discharge and lung tissues from affected cattle, while serial blind transfers of spleen suspension were made by yolk sac inoculation. One attempt was made to recover an etiological agent from the milk and blood of cattle in the early febrile stage of the disease by guinea pig inoculation. All attempts yielded uniformly negative results.

Bacteriological culture examination of tissues and exudates from the respiratory tract of affected cattle disclosed the usual mixed flora, none of the species being present constantly enough to be considered of etiological significance. However, from the last outbreak investigated pleuropneumonia like organisms (PPLO) were recovered with some difficulty from the nasal exudate of the three animals from which cultures were made. The significance of this finding is being investigated at the present time.

**A Preliminary Study of the Relationship of the Influenza-Like Disease Entity to Virus Diarrhea**

Inasmuch as virus diarrhea (VD) manifests itself in a diversity of clinical forms, the possibility that this was the condition being dealt with had been considered. The presence of VD in California had been suspected but failure to transmit the clinical entity that was encountered in the field raised some doubt as to whether the condition observed was VD or mucosal disease.

During the course of this study, two 5 to 6-month old Hereford calves which presented the typical symptoms of VD were brought to the Clinic of the School of Veterinary Medicine at Davis. Blood drawn from these just prior to death was injected into two calves from four to six months of age. One of these failed to react to the injection but the second reacted with a marked febrile response on the sixth day following inoculation. However, this calf gave no clinical evidence of illness other than slight depression and anorexia. Diarrhea was not present although a mild leukopenia was noted. By means of blood drawn from this animal at the
febrile peak a diagnosis of VD was established on an immunological basis, as shown in the following graph, by Dr. Charles J. York of Pitman-Moore Company, Indianapolis, Indiana (3).

**RESPONSE OF CALVES TO INOCULATION WITH THE CALIFORNIA AND THE N.Y. STRAIN OF V.D. VIRUS AND TO CROSS CHALLENGE.**

Graph 1

The presence of VD in the general area from which the experimental animals used in the transmission studies on the respiratory-like disease were obtained added further emphasis to the possibility that the latter was VD, and that failure to transmit an etiological agent was due to the fact that the experimental animals used were VD immune at the time of inoculation with materials from field cases. Accordingly, it was decided to test the immunity of the animals that had thus far received such materials to the VD virus. Furthermore, as a means of determining any possible immunological relationship between the two diseases, two recovered cases of the influenza-like condition were also included in the experiment. Previously uninoculated animals from the college herd served as controls for the virus. Each of the animals was injected intravenously with the New York strain of VD virus in the form of infectious cow blood. Temperatures and clinical observations were recorded twice daily and WBC counts were made at daily intervals thereafter until the termination of the experiment.

Following the usual incubation period, three of the four animals that had been exposed to the influenza-like disease by experimental injection developed the typical VD syndrome, and one died on the 15th day following inoculation. A response typical for all three animals is shown in the above graph. The fourth animal gave a doubtful reaction while the two recovered field cases and both virus controls proved refractory to the virus. The results of this experiment are summarized below.
Despite the apparent infectious and contagious nature of the influenza-like condition under investigation it would appear, on the basis of limited testing, that it is not transmissible, at least by means of blood and spleen from clinical cases of
the disease. While one of four animals inoculated intranasally with nasal and tracheal curettings developed a marked febrile response characteristic of that for the naturally occurring disease, the absence of clinical symptoms makes it debatable whether this represented a successful exposure. However, in this respect the disease might be analogous to VD and rinderpest in that a clinical distinction is frequently noted between the naturally occurring and the experimental infection. Nevertheless, in view of the fact that this particular calf had been used in the previous trial, and inasmuch as the other three test calves proved refractory on identical exposure with the same material, the significance that can be attached to this one isolated reaction is open to question.

The apparent failure to transmit an etiological agent might be attributed to one of several possibilities. It is conceivable, of course, that the condition is not infectious. However, little basis for this is provided either by the epidemiological and clinical features of the disease, or by the histopathological changes by which it is characterized. If this is sufficient evidence that the disease is an infectious entity, it would then appear certain that at least some of the materials used as inoculums in the transmission trials contained the etiological agent as these were collected from animals in various clinical stages of the disease and were thereafter inoculated with the minimum of delay. A second consideration would be the possibility that the disease, although infectious, is not readily transmissible, being similar in this respect to malignant catarrhal fever. In fact, based on the apparent failure of transmission trials and on the histopathological findings, it has been suggested that malignant catarrhal fever might possibly be the disease entity involved. However, the sharp contrast in certain epidemiological aspects and in the mortality figures between the two conditions would largely exclude the possibility that malignant catarrhal fever is the disease in question, at least in its currently recognized form. The most logical explanation for the negative transmission attempts and one which would not be at variance with the findings of McIntyre in this connection would be that the experimental subjects were immune as a consequence of previous natural exposure to the etiological agent. A parallel situation is found, once again, in the case of VD. Indications are that this disease is extremely prevalent, occurring frequently as a mild or subclinical infection, and that the great majority of cattle are eventually exposed with the consequent development of immunity.

It would appear, however, that the condition reported herein is unrelated to VD, despite the fact that only three of six cattle which were exposed either experimentally or naturally to the influenza-like condition reacted on challenge with VD virus. In view of the prevalence of VD and the fact all of the animals were over one year of age at the time of challenge (the two recovered field cases being four and seven years of age, respectively) these results are not unusual. Furthermore, the absence of a positive response in the control animals, both of which were obtained from the college herd in which VD had not hitherto been observed, reflects the finding of others (4) that this disease is extremely common and frequently escapes detection.

It is highly significant, however, that of the four animals which had been injected with blood and spleen from field cases of the influenza-like disease, three were subsequently found to be susceptible to the VD virus. Had the condition been VD,
blood and spleen from field cases would have been infectious since it was shown in subsequent work that the VD virus is present in the blood of animals in the terminal stages of the disease (3). Inasmuch as the experimental animals which were injected with field case materials were VD susceptible, it is inconceivable that they would have failed to react at this time while reacting to the virus from four to six months later. This finding would, therefore, appear to furnish adequate evidence that the influenza-like condition is unrelated to VD although it would be desirable to repeat this work using larger numbers of animals.

The above interpretation of the experimental results might be questioned on the basis that immunity to VD might possibly be of short duration, or that immunologically distinct strains of the virus exist, as in the case of bluetongue, with the result that reciprocal protection is not conferred by infection with recovery. Unfortunately no information could be found in the literature regarding the duration of immunity in VD. All strains of the virus thus far studied, however, have been found to be immunologically identical.

Inasmuch as the influenza-like condition under investigation cannot be identified with any currently known disease entity, the possibility of its being a modified form of either a native or an exotic disease must be considered. Because of certain clinical and histopathological resemblances, malignant catarrhal fever and mucosal disease should be considered in this connection. While indications are that a virus is the cause, the possible role of PPLO in this condition, either as a primary etiological agent or as a secondary invader, has yet to be determined. The diseases of exotic origin which should be considered in the same light as those referred to above include rinderpest, ephemeral fever, influenza of cattle, and bovine pleuropneumonia. What the actual relationship of any of these is to the influenza-like condition is, however, strictly a matter of conjecture at the present time.

In any event, the increasing economic significance of the condition in California calls for continued research as a means of establishing fundamental information about the disease which might ultimately lead to the development of adequate control measures. In view of the current reports from a number of other states of several apparently new cattle disease entities which might be related to the one encountered in California, the importance of the exchange of information and of cooperative research efforts cannot be emphasized too strongly in dealing with what might prove to be a common problem.

SUMMARY

An influenza-like entity which has occurred in cattle in California on several occasions during the past year is described with respect to its clinical, histopathological, and epidemiological features. An account of the experimental work thus far conducted, including etiological and transmission studies, and the relationship of the condition to VD is also presented.

Acknowledgements. The authors are indebted to Dr. J. E. Stuart, Chief of the Division of Animal Industry, California State Department of Agriculture; to Dr. M. D. Moys, Los Angeles Branch Office, Division of Animal Industry; and to Dr. F. P. Wilcox, Chief of the Los Angeles County Livestock Department, and his staff, all of whom cooperated in various ways in the studies reported in this paper. Acknowledge-
ments are due also to Dr. J. W. Kendrick and Dr. H. E. Adler, and to Mr. J. K. Saito of the School of Veterinary Medicine at Davis, for their contributions to the studies described herein. Financial assistance for a portion of these studies was furnished by the United States Department of Agriculture, Agricultural Research Service, Animal Disease and Parasite Research Branch.

REFERENCES


2. Ramsey, F. K.: Personal communication.


DR. FRANK A. TODD: The Committee is charged with the responsibility of studying the threat of foreign animal diseases that might enter the United States and Canada either by accident or by deliberate acts of sabotage.

During the past year we have attempted to carry out the recommendations that were made last year by this Association, to the effect that the Committee develop a Handbook on Foreign Animal Diseases that would contain information on handling specific foreign animal diseases, that the publication would be made available to the federal-state regulatory officials as well as practitioners, and would provide a concise directive to these individuals to follow in coping with what might be considered an emergency.

It was suggested that a Handbook of this kind would outline in 1-2-3 fashion the steps that should be taken to contact the person who would be helpful, and what the individual who saw the initial case should do until help arrives.

This material, with the approval of the Association and the approval of other federal and nonfederal agencies, will provide a uniform program throughout the United States and Canada for future control problems of foreign animal diseases.

Very important, a document of this kind, with the approval of this group, would provide an agreed plan of attack prior to any emergency that might confront us.

The report covers information developed by the Committee on Specific Animal Diseases that now or at least until recently was considered foreign to this country. It includes methods and problems of preventing the entrance of such diseases, the measure of control and eradication if they should appear. This Handbook has been prepared in a concise form, in order that it would be of immediate help to the practitioners or the regulatory officials.

As an aid in the quick identification of specific diseases, we have developed an abbreviated chart giving the salient points of each disease.

Information also is included on the methods of reporting animal diseases and the means by which additional help can be obtained in confirming the diagnosis, setting up quarantines, and instigating control programs.

An area that perhaps our profession has been neglecting is the problem of the insect vector. As we studied these groups of foreign or exotic type diseases, that area has been emphasized, so the problem of insect vectors and the part they play in the dissemination of some of these diseases, as well as their presence or absence in this country and, if they are present, their distribution throughout the country, has also been included.

The diseases that we have discussed are established in various parts of the world. They range in their effects from a slight debilitation and an economic loss, to those...
diseases that can decimate the livestock population. Several of the diseases that are included are transmissible to man.

Much of the information that is included in this report has only recently become available. Some of it is based on personal experiences of individuals who have worked with these diseases in the field. We have obtained much information from personal conversation and direct communications, and we feel that in this material we have the latest information available. Much of it has not been published outside.

This report should provide a basis for a uniform detection and control program throughout the United States and Canada in dealing with these possible unusual outbreaks of foreign and exotic diseases.

I have a few slides to show to very briefly summarize the contents of this book. There are twenty-seven diseases included in the report.

Disease affecting Swine
   African swine fever
   Teschen disease

Diseases affecting Cattle
   Bovine infectious petechial fever
   Contagious bovine pleuropneumonia
   East Coast fever
   Ephemeral fever
   Infectious infertility of cattle
   Lumpy skin disease
   Malignant catarrh
   Rinderpest

Diseases affecting Sheep
   Bluetongue
   Contagious agalactia
   Enzootic abortion
   Louping-ill*
   Nairobi sheep disease
   Sheep pox*
   Scrapie

Diseases affecting Cattle and Sheep
   Heartwater
   Nagana
   Rift Valley fever*
   Streptothricosis

Diseases affecting Cattle, Sheep and Swine
   Anthrax*
   Foot-and-mouth disease and other vesicular diseases

Diseases affecting Horses
   Venezuelan encephalomyelitis*

Diseases affecting Chickens and other Poultry
   Fowl plague
   Newcastle disease*

* Transmissible to man.
## FIGURE 1
### Description of Diseases

<table>
<thead>
<tr>
<th>Disease</th>
<th>Description</th>
<th>Cause and Dist.</th>
<th>Host</th>
<th>Symptoms</th>
<th>Path</th>
<th>Diagnosis</th>
<th>Incubation</th>
<th>Mode of Transmission</th>
<th>Communicability</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>African swine fever</td>
<td>Highly contagious and lethal febrile disease of pigs.</td>
<td>Virus in all equatorial and South Africa.</td>
<td>Domestic swine, wild bush pigs, warthogs.</td>
<td>Closely resemble hog chloera, rapid death 100% mortality, temp. 108° for about 5 days before rapid lysis and death. Cyanosis and focal hemorrhage of skin.</td>
<td>Similar to hog cholera, marked hemorrhage in lymph glands, mesenteric vessels, and alimentary tract.</td>
<td>Coarse, mortality, lesions, and inject hog cholera immune pigs and produce the disease</td>
<td>Stall contact 5-7 days experimentally 2-3 days.</td>
<td>Direct contact infected meat and material, &quot;carrier&quot; wild pigs</td>
<td>Virus present in excreta early in course of disease. Domestic pigs never recover. Carriers exist in wild pigs and warthogs. Pens remain infectious 2-3 weeks.</td>
<td>Quarantine slaughter, burn or bury carcasses, disinfection.</td>
</tr>
<tr>
<td>Rinderpest</td>
<td>Highly contagious, fatal virus disease, disease of cattle and other ruminants.</td>
<td>Virus—Asia and Africa.</td>
<td>Cattle and other ruminants Also pigs.</td>
<td>High fever, nasal and lacrimal discharges, dehydration, emaciation, erosions of buccal and digestive tract muco-sae with congestion and hemor-rhage.</td>
<td>Emaciation erosions in mouth, congestion and/or hemorrhage with erosions in digestive tract. Endocardial hemorrhage and em-physema.</td>
<td>Presumptive-composite picture of course and lesions. Confirm by inoculation of im-munes and controls; virus-serum test.</td>
<td>3-9 days</td>
<td>Direct or indirect contact with infected animals or that their fresh secre-tions or excretions.</td>
<td>Indigenous cattle and wild game in enzootic area may carry virus inapparent forms for considerable time.</td>
<td>In new areas stamp out by quarantine and slaughter. In enzootic areas vac-cinates.</td>
</tr>
</tbody>
</table>
Several diseases in this report are already present in this country. In the past we have looked upon a good many of these unusual diseases as problems that are or were peculiar to Asia, Africa, South America, or wherever they happened to be found. The experience we have had in this country during the past several years should convince us that these diseases can gain entrance into this country, not only those diseases that are highly communicable but also those diseases that are dependent upon an insect or an orthopod vector for their means of transmission.

Our modern rapid intercontinental air transport provides a daily threat as a source of introduction of these diseases, accidentally or otherwise. We should, therefore, keep in mind that any of these diseases might gain entrance into this country.

**Disease**

**(Synonyms)**

I. **IDENTIFICATION OF DISEASE**
   a. Definition
   b. Etiology
   c. History

II. **SYMPTOMS**
   a. Clinical features
   b. Incubation period
   c. Course

III. **PATHOLOGIC CHANGES**
   a. Pathogenesis
   b. Post-mortem lesions

IV. **DIAGNOSIS**
   a. Clinical
   b. Laboratory
   c. Differential diagnosis

V. **PROGNOSIS**

VI. **EPIZOOTIOLOGY**
   a. Geographical distribution
   b. Transmission
      (1) Source of infection
      (2) Modes of transmission
      (3) Communicability
   c. Season and climate
   d. Hosts

VII. **CONTROL**
   a. Preventive measures
   b. Epizootic measures
   c. Treatment
   d. Immunization
   e. Import restrictions

VIII. **PUBLIC HEALTH ASPECTS**

IX. **REFERENCES**
## FIGURE 2

### Diagnostic Test for Foreign Animal Diseases

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>African swine fever</td>
<td>None</td>
<td>Blood, organs, especially spleen.</td>
<td>Not established</td>
<td>Inject pigs immune to hog cholera with blood, fluid, organs.</td>
<td>Not available</td>
<td>Not developed</td>
<td>Not developed</td>
<td>Not developed</td>
</tr>
<tr>
<td>Rift Valley fever</td>
<td>None</td>
<td>Blood of infected mice and chicken embryos.</td>
<td>Focal necrosis particularly in liver. Intranuclear inclusions in liver cells.</td>
<td>Mice intraperitoneally succumb in 3 days. Antiserum will protect. Cattle and sheep susceptible.</td>
<td>Mouse protection test</td>
<td>(4 to 6 days)</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Rinderpest</td>
<td>None</td>
<td>Spleen and lymph glands</td>
<td>Inflammatory lesions of all organs and tissue, particularly alimentary tract.</td>
<td>Ruminant, swine. Rabbits and chicken embryos susceptible to adapted strains.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

The above outline was followed in describing each disease.

Figure 1 illustrates a chart included giving brief descriptions of the symptoms and pathology and diagnosis of these various diseases. I have used these three diseases—African swine fever, Rift valley fever and Rinderpest, only to illustrate this chart.

Theoretically, the practitioner or regulatory official may see an unusual disease. He sees the host, certain symptoms, and certain pathologic changes. By comparing the information that he observed with the chart, it will be a guide for further study and action.

Figure 2 again illustrates a chart developed giving the approved diagnostic procedures for each of the diseases included in the report. We think this will be helpful to the individual in the diagnostic laboratory, and also helpful to the practitioner and the regulatory official, in pointing out the specimens or the tissues that would be necessary to carry out the diagnostic procedures. In the third column we have listed the specimens or the tissues that are required to carry out the established diagnostic procedures for the virus diseases. Along with the chart on the laboratory procedures we have also included a section on the preparation of library specimens to be sent to the laboratory.

Figure 3 illustrates a chart developed giving the control measures for the diseases included in the report. This is divided into two sections. The last line is the eradication measures that would be followed.

You will notice that Rift Valley fever happens to represent one of those diseases where there is an insect vector. It is possible that by the time the disease is recog-
CONTROL MEASURES FOR FOREIGN ANIMAL DISEASES

<table>
<thead>
<tr>
<th>Disease</th>
<th>African Swine Fever</th>
<th>Rift Valley Fever</th>
<th>Rinderpest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Disease</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2. Notification of outbreak</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Quarantine restriction of livestock movement</td>
<td>Farm Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Prohibition of sale or movement of animal products</td>
<td>Meat, feeds, hay, litter, etc., Misc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Emergency slaughter</td>
<td>Infected Contact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Carcass disposal (rendering plant)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Carcass disposal (burning, burial)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Prohibition of skinning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Cleaning, disinfecting premises</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Indemnity</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>11. Immunization</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Specific eradication measures</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Control measures: Required

nized it will be established in our insect population. In that case, or in a case where the disease becomes endemic or widely scattered, then the second part (the top of the slide) would be applied for control procedures.

In this chart, then, we have the eradication procedures and the control procedures. In each case we have very briefly described the eradication procedures.

Figure 4 represents the reporting system we speak about from time to time.

1. When the farmer observes evidence of an unusual disease such as one of vesicular character or of suspected foreign origin, he should report it immediately—either to his local veterinarian or directly to the State Livestock Sanitary officer.
CHANNELS OF LIVESTOCK MOVEMENT FROM FARMS IN THE CORN BELT REGION TO PACKING PLANTS, OTHER FARMERS AND OTHER USERS, 1940

CATTLE AND CALVES

HOGS

SHEEP AND LAMBS

--- A --- Less than 0.5 percent

Figures on lines are in percentage

SOURCE CORN BELT LIVESTOCK MARKETING RESEARCH COMMITTEE

U S. DEPARTMENT OF AGRICULTURE

BUREAU OF AGRICULTURAL ECONOMICS
2. This officer and the USDA Veterinarian-in-charge make a preliminary investigation.
3. If findings warrant it they arrange for the help of specially trained USDA diagnosticians.
4. In event the disease is determined to be a dangerous infection, State Livestock
Sanitary authorities set up quarantines and join with Federal regulatory officials in establishing controls or eradication measures.

Figure 5 illustrates one of our big problems in disease control in this country—livestock marketing practices. This chart shows the practices of bringing animals in from all corners of the country to concentration points, and from there to packing...
houses, with their products distributed throughout the country; or at these concentra-
tion points they may be purchased and taken back to the farm for further feed-
ing, to be brought back at later date. That fact, plus the speed with which these
movements are made, are two of the major factors that make animal disease control
very difficult in this country.

Figures 6, 7, 8 and 9 show the livestock distribution in this country and empha-
sizes the areas where some of these problems and diseases might appear.

The report includes a section on epizootiology. Not that we are all going to be
epizootiologists, but this information may provide a guide that may be helpful in
working out the methods of transmission and control of these unusual diseases.

In addition to the material we have illustrated, and a description of the diseases,
a number of appendices have been included. One lists the approved disinfectants
that apply to each disease included in the report and effective insecticides and
larvacides and insect repellants that are important and useful weapons in our con-
trol procedures for these diseases.

The last appendix includes a list and review of those films and visual aids that
are available now, illustrating in movie form the diseases that are discussed in the
report.

The Committee again wants to recommend that this report be developed into a
Handbook on Foreign Animal Diseases and made available to all veterinary stu-
dents, practitioners and regulatory officials.

Since there are a number of diseases included in this report that affect man, per-
haps some of the medical schools, public health schools and the public health officials
will be interested also in the information contained in this report.

We submit this report for your consideration.

President Green: Thank you very much, Dr. Todd. I want to offer you and
your Committee special thanks for this wonderful contribution. I believe our Execu-
tive Committee has had an opportunity to at least thumb through the report, and
I can't begin to tell you the number of complimentary remarks I have heard about
it. It is a magnificent piece of work, and one that will find its place in every library,
every veterinary school, and every office of a veterinary official in the United States.
Your Secretary asked that I report to this Convention in brief on the position of the Agricultural Research Service in relation to animal morbidity and mortality reporting. This perplexing problem has absorbed the attention and thought of the Association almost since its first organization, and I presume that if the records of discussions of the first meeting were fully preserved, we would find that this subject had its place there.

Man's ageless struggle against disease becomes more complex and more urgent as the intensity of population and interchange of commerce increase. This is the effect whether we are speaking of animal diseases, plant diseases, insect pests, or diseases of the human family. This enlargement of the problem as the years go by is illustrated by a statement that is often made, and which I believe accurately portrays the situation. It is this—that as the animal population of an area doubles, the disease and pest problems increase 4-fold.

We in this country have enjoyed a long development period of expanding into fresh new lands with relatively low concentration of human population, livestock and crops. But the advantages of our natural heritage in this respect are fast diminishing as the leveling effects of our national growth within a fixed land area bring us ever closer to the more urgent disease problems long faced by older countries.

Many of those countries kept abreast of the problems as reflected rather accurately in their political, economic and social well-being. Others failed to meet the challenge and gave way to the ravages of devastating plagues and pests, reducing them to a constant struggle for bare survival. It is but stating the obvious that the United States dare not fall among the second grouping.

A few months ago the Agricultural Research Service, in cooperation with other Departmental and Federal agencies, made a preliminary appraisal of losses of all kinds in agriculture. The compilation shows that we have already come to the point where the average annual losses in livestock and poultry from diseases, parasites and insects amount to $2,688,000,000 during the period 1942-1951.

A complete system of animal morbidity and mortality reporting is not a "cure-all" nor in itself a preventive against the inroads of animal diseases and pests. It is one of the important foundation stones in a sound structure of animal disease prevention, control and eradication. The Association has recognized the need and actively worked toward establishment of a complete reporting system for many years.

In 1920 the Association adopted the following resolution: "Whereas, it is the sense of the Association that there should be gathered monthly or periodically animal health statistics, same to be published and distributed from the various states;"
“BE IT RESOLVED by the United States Livestock Sanitary Association, That
we recommend that the livestock sanitary authorities of each state take steps to
gather reliable information concerning the health of livestock in the state with
definite information as to any and all existing outbreaks of communicable diseases,
and that the information thus gathered be forwarded to the Chief of the Bureau
of Animal Industry, United States Department of Agriculture, with the request
that the statistics and the information thus gathered be edited and published by
the department and distributed to the various state sanitary boards in sufficient
quantity so that distribution may be made among those interested in animal health
and livestock sanitation in the various states.”

“BE IT FURTHER RESOLVED, That the chair appoint a committee of five from
the membership of the Association, including the Chief of the Bureau of Animal
Industry as chairman, to devise ways and means for the carrying out of this reso-
lution.”

At the 1944 Convention, the Committee on Miscellaneous Transmissible. Dis-
eases reviewed the more important outbreaks of animal diseases during the previous
year, and the Committee on Legislation, commenting on the value of such informa-
tion, particularly as it related to information disclosed on antemortem and post-
mortem inspections under the Federal meat inspection program, called for a corre-
lation of such information with that derived from State sources and a systematic
reporting for disease prevention and control purposes.

In 1945, the Committee on Miscellaneous Transmissible Diseases gave careful
attention to this subject, recommending a “Division of Vital Statistics” in the
Bureau of Animal Industry, and the establishment of diagnostic laboratories
throughout the United States. The Committee on Vital Statistics of the American
Veterinary Medical Association also gave full attention to this problem, compiling
a list of suggested reportable diseases occurring in domestic livestock and poultry.
A Committee on Veterinary Services for Farm Animals of the Agricultural Board,
National Research Council, conducted a survey jointly with the Iowa Experiment
Station, the Bureau of Animal Industry, and the Bureau of Agricultural Econom-
ics.

In 1947, upon its own recommendation, the Committee on Miscellaneous Trans-
missible Diseases became the Committee on Morbidity and Mortality, and in that
year the Committee conducted an extensive survey of the needs for such informa-
tion, the ways in which it might be gathered and distributed, and the Federal,
State, and private agencies that might participate.

In 1949, the Committee again reviewed the situation and made recommenda-
tions, which were adopted and which have been reiterated in similar form at each
succeeding convention. The recommendations (using the language of the 1952
report) were:

1. Assist the United States Bureau of Animal Industry in establishing a system
for the collection and dissemination of obtainable livestock morbidity and
mortality statistics, in cooperation with state livestock sanitary officials.

2. Expedite publication and distribution of:
   a. A manual on nomenclature
b. A manual on the diagnosis and epidemiology of economic and transmissible diseases of animals.

"3. Prepare the practicing veterinarian and the veterinary student, through all available means and agencies, to give freely honest and complete reports to the chief livestock sanitary officials on veterinary morbidity and mortality within their states.

"4. Continue to encourage support of and interest in the program for gathering vital statistics. To this end, the Committee has recommended that colleges of veterinary medicine consider the incorporation of a course of vital statistics in the curriculum to acquaint the veterinary student with the part he will play as the initial source of morbidity and mortality data, to imbue him with his obligation, and to teach him to interpret properly and evaluate statistical data which will be made available to him as a result of his effort."

The Committee further commented that "in the intervening years this committee has had much encouragement by verbal acclaim, but no real fundamental cooperation. A national reporting agency has not been established. The manuals on nomenclature and diagnosis and epidemiology are not ready for publication."

Last year the Committee recommended, and the Association adopted an interim procedure whereby State livestock sanitary officials would send reports to the Executive Secretary, and the Secretary would return a monthly tabulation. I believe the States have participated in this activity in varying degrees during the past year.

While this effort was being made by the Association, the Bureau of Animal Industry had not been idle. I have not searched the record farther back than 6 years, but at least during that time formal requests were initiated each year for the establishment of a reporting system. None of those requests were granted, and accordingly, the Bureau had the unpleasant task of explaining its lack of action year after year at the meetings of this Association.

It does seem appropriate, however, at this point to recall your attention to the many reports of great value in this field, which are regularly made available to, or published by the State livestock sanitary officials and the Bureau of Animal Industry, these latter now being continued by the Agricultural Research Service.

1. The comprehensive annual report on the incidence of rabies in the United States.

2. A similar report on equine encephalomyelitis.

3. The monthly summaries of the incidence of anthrax in the United States.

4. The annual reports of antemortem and post-mortem findings on inspection of animals under Federal meat inspection.

5. The annual reports of antemortem and post-mortem findings on inspection of animals under State inspection.

6. The monthly and annual summaries of the incidence of brucellosis and tuberculosis of cattle.

7. The annual summation of the results of pullorum-fowl typhoid testing under the National Poultry and Turkey Improvement Plans.

8. The frequent summary reports of outbreaks of vesicular exanthema since July 1952.
9. The reports as they occur of outbreaks of scrapie.
10. The reports from time to time of the incidence of blue tongue.
11. Ten States are now operating a disease reporting system using the report form developed by the Communicable Disease Center of the United States Public Health Service. This work is handled cooperatively by the State and Federal livestock sanitary officials, the State and Federal Public Health Services, the State Veterinary Medical Association, and the School of Veterinary Medicine.
12. Several States are operating reporting systems similar to the above, but with report forms other than those developed by CDC.
13. Last but not least in this list should be recorded the considerable volume of information on the incidence of animal diseases, more especially those of outbreak character, which come to the State and Federal livestock sanitary officials in the normal course of their official duties. This information comes from innumerable sources and is handled in the network of State and Federal organizations in various ways, depending upon the experience of officials and the needs of localities. As much of this information is not published, there is a general lack of appreciation of its existence, but as all of you in regulatory work know, it is the bed-rock upon which you make most of your decisions. Illustrative of this kind of animal disease intelligence is the system of telephonic or telegraphic reporting of vesicular diseases and of other conditions that might be the first indication of an exotic plague.

In addition to the above, there are of course the summaries of post-mortem examinations of poultry issued by the Agricultural Marketing Service, the frequent reports issued by the Veterinary Division of the United States Public Health Service, the Veterinary Services of the Armed Forces, and the published information from college and university Divisions of Veterinary Medicine.

Taken all together, this makes quite an imposing list. It is recognized immediately that the information in many cases is gathered and collated for a variety of purposes, many of which do not lend themselves to the most efficient reporting, and that there is no national coordination, summation, and evaluation of this work. It is toward these latter goals that the Association has been striving these many years.

Now, as to the “plans” which are the principal subject of this discussion. The need for action and not words is obvious from the review of past and present activities. The Agricultural Research Service has set for itself the task of determining what measures can be taken toward the goal of complete animal morbidity and mortality reporting. Under the direct leadership of Dr. C. D. Van Houweling, a committee is being established with a clear-cut directive to get at the root of this problem from the Federal standpoint so that we may obtain an authoritative decision as to whether the Agricultural Research Service should proceed in cooperation with the States to establish a nationally-coordinated reporting system.

The Committee is analyzing the present situation, taking into account all of the advances that have been made in recent years, and is assessing the real measure of the need for Federal participation from the standpoint of its responsibilities in the protection of the health of the Nation’s livestock. There is no question that veterinarians and other professional people support the idea of a national reporting system. Our past experience in attempts at initial financing of the venture makes
it crystal-clear that the direct benefits to the raising of healthy livestock must be fully understood. It is particularly important that this understanding reach the livestock producer. Obviously, the interest of veterinarians and other professional people has not in itself served to gain financial support for a reporting program.

Doctor Van Houweling and his group already have done a good deal of the ground work. Preliminary outlines of a nationally coordinated reporting system will be discussed with representatives of the profession and the industry to obtain the benefit of their ideas in formulating a system best suited to serve their needs. We believe that if they have had voice in the discussion and planning they will support any plan which may later be put into effect. We expect that the study will require about six months. If further action by the Agricultural Research Service is then indicated, specific plans and program will be presented for consideration in the Department's budget. Our people will be calling upon many of you for information and counsel during this time. As in all other matters in which we work together, I know we will receive the utmost in helpful cooperation.
REPORT OF COMMITTEE ON MORBIDITY AND MORTALITY

W. L. Bendix, Chairman, Richmond, Virginia; Raymond Fagan, Kansas City, Kansas; K. F. Wells, Ottawa, Ontario, Canada; H. E. Goldstein, Columbus, Ohio; J. H. Sauter, St. Paul Minnesota; C. D. Lowe, Washington, D. C.

The long-time objectives of this Committee have been set forth in previous reports. Among the objectives previously listed we find the following:

1. Assist the United States Department of Agriculture in establishing a system for the collection and dissemination of obtainable livestock morbidity and mortality statistics in cooperation with State Livestock Sanitary Officials.

2. Expedite the publication and distribution of: A manual on nomenclature and a manual on the diagnosis and epizooology of transmissible diseases of animals.

3. Prepare the practicing veterinarians and others to give the necessary information on veterinary morbidity and mortality.

4. Continue to encourage support of and an interest in the program for gathering these vital statistics.

The main support for an adequate reporting system emanates from several professional groups directly or even vitally concerned, but this support continues to be mostly verbal. The professional groups directly concerned are the Public Health Service, State Livestock Regulatory Agencies, and the Civil Defense Administration. Each has a valid and continuing interest, and each one a different area of responsibility based upon this interest. The Public Health Service's primary concern is the zoonoses. State Regulatory Agencies are interested in the economic importance of livestock diseases. Control and eradication are based directly on this principle and are financed on the basis of economic justification. The Civil Defense Administration is of course concerned with the potential threat of biological warfare.

Previously your committee has submitted a list of diseases that it considered the minimum to be covered by an adequate reporting system. Some of them are zoonotic and are therefore of considerable interest to Public Health, and several of them are, or could be, a matter of concern to the Civil Defense Administration. All of them, however, are of interest and concern to State and Federal Regulatory Agencies and to the livestock industry. State and Federal Animal Disease Regulatory Agencies are the only agencies having a direct interest in all of the animal diseases and also the only agencies with an established nationwide staff competent to deal with them.

Your committee previously suggested that a system of national morbidity reporting be established within the framework of this association. This recommendation was made with considerable misgivings and has not met with success. It was foredoomed to fail, mainly because it was a too radical departure from the historic sphere of activity of this association. Interest continues to grow however.

At present TEN states are operating a disease reporting system and using the facilities of the Public Health Service to assist them. TEN other states are either operating such a system or are seriously interested in doing so.
In an effort to encourage the proper development and growth of animal disease reporting so that all segments of the nation’s health and economy will be served, your committee recommends the following:

I. That it be stated as the official opinion of the United States Livestock Sanitary Association that the matter of animal morbidity and mortality reporting is the direct responsibility of the Federal Animal Disease Regulatory Agency.

II. That this agency accept this responsibility and proceed, in cooperation with State Regulatory Agencies, the Public Health Services, and Civil Defense Interests to inaugurate such a reporting system at the earliest possible date.

III. That the next committee on Morbidity and Mortality contain representation from the professional groups herein listed and from the national livestock and farm organizations and from the meat packing industry. It will take the combined efforts of all professional groups interested and all segments of industry to establish an adequate reporting system and to see that it is properly financed.


V. That the manual so prepared, when approved, be published and distributed by the United States Livestock Sanitary Association.
Common or psoroptic scabies in cattle was rather widespread after the turn of the century and became fairly common among range herds of the West and Northwest. By 1935 the disease had been virtually eradicated from this country through the persistent efforts of Federal and State livestock disease control agencies. The last case of psoroptic cattle scab with which I was personally associated was introduced into Catron County, New Mexico in 1946, and was eradicated that same year. The absence of any reported cases of this form of scabies in the past several years led to the assumption that the disease had possibly been eliminated from the United States. It came as a surprise, therefore, when in January 1954 the Arizona livestock disease control agencies reported finding extensive cases of psoroptic scabies among some Hereford steers shipped into Maricopa County in October 1953.

I was requested to lend technical assistance in identifying the parasite and to advise on the use of benzene hexachloride or lindane to eliminate the disease. Subsequently, instructions were received to extend like assistance also to Colorado authorities, and to attend the meeting of Federal and State livestock sanitarians on March 5, 1954 at Salt Lake City, Utah, where representatives from 16 western States assembled to discuss cattle scabies eradication. Recommendations were presented to the conference encouraging the use of chlorinated hydrocarbon compounds in the hope of effecting early eradication of this recent outbreak of cattle scab.

STATES INVOLVED IN OUTBREAK

The origin of cattle scabies in Arizona was traced to a consignment of 980 head of Hereford feeder steers shipped from near Lamar, Colorado late in September 1953. However, they were not native Colorado cattle, but had been in the State only about six months. When the Colorado authorities learned of scabies being present in cattle shipped from their State to Arizona, they immediately notified authorities in the other States which had received recent shipments of exposed cattle from the Lamar area. Scabies was thereafter found in a shipment of cattle which had been moved in November 1953 to the Imperial Valley in California from a pasture adjoining the initial Lamar infestation. Other contact cattle had likewise been shipped from Colorado to Oklahoma, to the Panhandle of Texas, and to Missouri, and scabies was found at destination of each of these three consignments. Some 13 exposed cattle had also been inadvertently shipped about January 7, 1954 from Maricopa County, Arizona to the Imperial Valley in California, and through information from Arizona, two incipient cases of scab were found in those cattle ten days later.
In addition to finding scabies in cattle in the Imperial Valley, which had their origin near Lamar, Colorado and in Maricopa County, Arizona, a shipment of cattle from Eagle Pass, Texas was also found infested in Riverside County, California. The origin of scabies in this shipment remains undetermined, because no scabies was found by Texas authorities in the remaining cattle in the area around Eagle Pass. It is possible that the cattle in question might have had contact with scab-infested cattle while enroute to California, because the railroad officials reported the escape, temporarily, of cattle of that shipment from one of the railroad stock cars after they had been reloaded at a point where they had stopped for feed, water and rest.

Scabies was also found in cattle near Clint, in El Paso County, Texas, and the exact origin of this infestation, according to the information available to me, has likewise not been definitely determined.

While the existence of psoroptic cattle scabies in southeastern Colorado was confirmed, its origin or introduction into that area still remains undetermined. It may be significant, however, to state that the scab lesions observed in the southeastern Colorado herds that remained in that area were not nearly so extensive in the actual percentage of cattle affected, or in the extent of the lesions on the individual animals, as were the scab lesion cases observed in the Lamar shipment to Arizona.

The last known scabby cattle in southeastern Colorado, so I have been informed, were officially dipped some 15 years or more ago, and I cannot believe that the present outbreak in that area could have any connection whatsoever with that earlier infestation. In working with cattle scabies for years in the Southwest, I found that the disease did not behave in that manner. Likewise, there is no connection, insofar as I can determine, between the outbreak in southeastern Colorado and the last case of cattle scabies with which I was personally associated in 1946 in western New Mexico.

In observing the longevity of psoroptic cattle scab mites in skin scrapings maintained under laboratory conditions, it was found to be ten days for mature mites. Mites continued to hatch from eggs in the skin scrapings for 18 days from the time they were collected. These newly hatched mites did not survive for more than two or three days. Under semiarid conditions that obtain at Albuquerque, New Mexico, adult mites maintained in the open air rapidly became dehydrated and died in less than 48 hours time. It is obviously unlikely, therefore, that cattle scab would survive in so mild a form as to be unobserved in native cattle in Colorado for over 15 years.

Another interesting point of observation is that psoroptic mites of cattle and those of sheep are indistinguishable, as shown by comparing photomicrographs at 150 magnification. Mites belonging to the genus and species Psoroptes equi are, however, separated into different varieties according to the host they infest. Cross-transmission from one host to another was first observed in 1951, when we reported such natural cross-transmission from sheep to two cattle, which took place at our laboratory in Albuquerque. These scabies mites have been maintained on a cow and a bull for over three years. During this period, the scab mites have been transplanted repeatedly from these two infested animals to a number of sheep and
cattle, producing in each instance the characteristic lesions of psoroptic scabies on each respective new host. Such cross-transmission is not of common occurrence, however, and probably requires an especially susceptible host animal before it can occur. In the course of time, the mites seemingly adapt themselves to an existence on the heterologous host. Such cross-transmissions could have accounted for possible outbreaks of cattle scabies of undetermined origin in past years. Because the origin of at least three separate area infestations during the outbreak early in 1954 were not definitely determined, I feel that a word of warning may be in order to the effect that future outbreaks of cattle scab might reasonably be expected to occur, probably somewhere in the Southwestern States.

DESCRIPTION OF SCABIES ON CATTLE

Scabies is a destructive disease of cattle, manifested as a serious inflammation of the skin caused by mites technically known as *Psoroptes equi* var. *bovis*. These mites have sharp mouth parts with which they pierce the skin to obtain serum for their nourishment. They introduce a poisonous secretion into the wound which causes an intense pruritis accompanied by inflammation, swelling, and exudation of serum from the wounds. The excess serum that continues to exude from an active skin lesion becomes mixed with cast-off tissue cells and dirt particles, which dry and harden to form the characteristic yellowish crusts or scabs.

As the disease progresses, the skin in the oldest parts of the lesions become chronically thickened, hardened, dried and wrinkled. Scab mites are not usually found at the site of these chronically thickened skin lesions. They are unable to obtain nourishment from such areas, and must therefore seek healthier portions of the skin for their sustenance. The result of mite propagation with the progeny seeking healthier skin on which to feed causes the lesions to increase in size at its periphery. Live mites are usually most numerous in skin scrapings taken from the periphery of the lesions, especially when it is active and is still undisturbed by repeated hand manipulation.

The lesions are usually first observed over the withers, over the back, and around the tail head; occurring in frequency at those locations in about the order named. In time, the lesions spread from these locations to other areas and may eventually involve the entire body. The infestation at times becomes so extensive and so severe as to terminate in the death of the infested animal. Severe cases like those just described were observed in the Arizona outbreak.

In an effort to relieve the itching and irritation, the infested animal vigorously bites, rubs, and scratches the lesions with an intensity characteristic of scabies, and in so doing produces raw and bloody lesions. The thickened, and inflammatory condition of the skin, characteristic of scabies infestations, can be readily detected by pinching up a portion between the fingers and comparing it with the surrounding healthy skin. Most other skin conditions affecting cattle, including extensive infestations with lice, need not be confused with scabies because this consistently thickened skin is characteristic only of scabies. A positive diagnosis of scabies, however, depends upon finding the causative mites and identifying them to establish the specific kind involved.

There is usually a seasonal fluctuation in the activity of cattle scabies lesions.
PSOROPTIC CATTLE SCABIES OUTBREAK

They become progressively active through the late fall, winter and early spring months. During the hot months of the year, however, they show a tendency toward partial or complete resolution, only to become reactivated later as cooler weather approaches.

TREATMENT WITH WETTABLE BENZENE HEXACHLORIDE AND LINDANE

Treatment of several thousand cattle involved in this outbreak provided an excellent opportunity to test on an extensive scale the effectiveness of benzene hexachloride (BHC) and lindane as miticides. All the animals involved in this outbreak were treated by spraying or dipping, usually at 10- to 14-day intervals, with either wettable BHC or wettable lindane having a concentration of 0.075 per cent gamma isomer. The recommendation we made on the use of 0.075 per cent gamma isomer of wettable BHC or lindane for psoroptic cattle scabies was based on results obtained with previous experimental spraying tests conducted in New York, Illinois and South Dakota for cattle scabies caused by mites of the genera Sarcoptes and Chorioptes. These tests were carried out in 1950 and 1951 when we were considering the possible spread westward of both chorioptic and sarcoptic scabies from the East.

The outbreak of psoroptic cattle scabies in the West necessitated the inspection of over one million head of cattle, but actually involved only 9,851 head in the 28 infested herds. These herds were located in 14 counties of six States. The apparent elimination of the disease required 28,781 individual animal treatments, employing mostly wettable BHC. Within less than three months after reporting the disease, all known infested and exposed cattle had received one or more treatments. Post-treatment examinations in 30 to 60 days of some of the most advanced cases of scab in several herds showed recession of lesions and absence of mites. The success of the treatment and the prompt elimination of the disease must be credited primarily to the early diligent work of both Federal and State livestock disease eradication agencies in the States involved. A final examination of the cattle treated during this outbreak should, however, be made this winter and next spring to determine conclusively the effectiveness of the BHC treatments used, and the thoroughness with which the eradication measures were carried out.

METHOD OF APPLYING TREATMENT

After long years of use, I am still a confirmed dipping enthusiast, and if I want to be certain beyond any question of doubt that each animal has been adequately treated, I prefer to use a dipping vat. However, the mechanics of spraying equipment seem to meet with popular favor, and few, if any vats are now available. The spraying method, therefore, was given extensive trials in this outbreak. Two types of spraying equipment were used, namely, the so-called “spray-dip” machine and the orchard-type power sprayer. The spray-dip machine is the nearest approach to the standard dipping vat that I have seen. It consists of a rectangular steel cage with hinged steel doors at both ends, and its pumping facilities deliver the spray onto the cattle under pressure through multiple spray outlet nozzles strategically placed at various angles inside the cage, which holds one animal at a time. The machine has facilities for recovery and reuse of some of the excess liquid.
drained off the animals. There is a tendency for the spray nozzles to clog with debris, and also with rust scales, especially if the machine has previously been used with the chlorinated hydrocarbon compounds, which are terrific rust producers.

The orchard-type power sprayers, equipped with two lead-off lines with trigger-type spray guns, were used for treating most of the cattle. The spraying method, using either high or low pump pressure, proved more effective than was earlier anticipated. The effectiveness of the spraying method depends on the thoroughness of the operator in wetting the entire body surface of each animal. Complete coverage of cattle one or more years of age requires the use of from four to eight gallons of the spray liquid.

Dipping will prove far more practical and less time consuming than spraying, especially when large numbers of cattle must be treated within a reasonable length of time. Since neither BHC nor lindane is bactericidal nor bacteriostatic, it is essential to change the vat contents frequently because they tend to become filthy and contaminated. Filthy dip turns a blackish color, and gas bubbles may be seen rising to the surface. When this happens, the vat contents should be changed regardless of the number of cattle that passed through the dip or the number of days it has been in use. Changing dips often may be the means of preventing the occurrence of wound infections.

CAUTION WARNINGS

Seven distinct items must be kept in mind in connection with BHC dips; (1) Do not permit any of the dip to drain into fish streams or stock watering ponds because it may kill fish and livestock. (2) Do not allow dip to accumulate in puddles, or drain onto vegetation or feeds where animals may be poisoned through drinking the liquid or eating the contaminated feeds. (3) Do not under any circumstances heat the dip or the spray liquid above 80°F. (4) Do not use the milk from dairy cattle for seven days following treatment. (5) Do not slaughter beef cattle for 30 days after treatment with BHC. (6) Do not mix BHC or lindane with any parasiticidal dips in common use, including lime-sulfur, nicotine-sulfate, and arsenical solutions, because losses have occurred where this warning was not heeded. (7) Do not treat severely emaciated and physically weakened cattle, or very young animals, especially very young dairy calves. Such animals are particularly susceptible to poisoning.

TOXIC REACTIONS IN EMACIATED YOUNG CATTLE

During the period of the eradication program in Arizona, approximately 10,000 individual dippings or sprayings of cattle were accomplished on farms in Maricopa County. These farm cattle were in fairly good physical condition and were, therefore, not affected by the treatment at any time. However, in compliance with the Arizona requirements on cattle importations, to prevent introduction of psoroptic scabies, 5,900 head were dipped at the Tovrea Stockyards, near Phoenix. Toxic reactions were noted, and limited losses occurred among Brahman and Brahman-crosses shipped to Phoenix from areas in Texas which had been subjected to prolonged drouth conditions. These cattle ranged in age from six months to two years,
and they were for the most part weak and severely emaciated. Toxic symptoms were reported with all concentrations used, from 0.04 to 0.09 per cent gamma isomer, and in all cases the most severely emaciated and weakened individuals were the ones affected. There was no discernable difference between the toxic manifestations caused by BHC and lindane. The death losses among calves in such poor physical condition was probably not significantly higher than losses occurring in past years when lime-sulfur, nicotine sulfate, and arsenical dips were used.

Toxic symptoms in these severely emaciated cattle usually appeared within a period of 24 hours, but in some animals trouble became evident as early as two hours and in others there was a delayed reaction until 48 hours after dipping. The symptoms were aggravated by undue exercise while handling the cattle in the stockyards.

It is known that most chlorinated hydrocarbon materials are absorbed into the animal body and deposited predominately in the fatty tissues. The lack of body fat apparently predisposes poisoning by the chlorinated hydrocarbons. Inasmuch as one cannot readily determine from outward appearances the amount of fat deposition within the animal body, it is recommended that severely emaciated animals be withheld from treatment until their physical condition becomes materially improved by supplemental grain feeding. Animals intended for dipping should be carefully examined to determine if their physical condition will permit dipping in chlorinated hydrocarbon compounds, without the probability of toxic symptoms or actual losses.

EFFECTIVENESS OF SINGLE SPRAYING

In laboratory tests, cattle scabies mites in skin scrapings that were submerged in a concentration of 0.075 per cent gamma isomer continued to show leg movement for 15 minutes after dipping. Thirty minutes after dipping only about 25 per cent of the mites showed occasional feeble leg movements. All mites were dead one hour after they had been exposed.

Through the courtesy of the livestock regulatory authorities of Colorado, arrangements were made for two small groups of well isolated cattle, showing extensive lesions of scabies and with mites present in large numbers, to be sprayed only once with BHC at a gamma isomer concentration of 0.075 per cent. The acaricide was applied with a low pressure, orchard-type sprayer and the operators were conscientious and thorough in completely wetting every animal. Post-treatment examinations at 30 and 42 days, respectively, revealed no live or dead mites in skin scrapings taken from several previously active lesions. Additional examinations would be required over a much longer period before reaching a conclusive evaluation of the one-spraying method. The cattle were released for immediate slaughter after that interval as previously agreed with the owners. However, the result obtained can be considered as indicative of the probable effectiveness of a single spraying treatment. Additional tests on a more extensive scale should be made as opportunity to do so arises. I hope you folks in attendance at this meeting, who are the guardians over the health of the livestock in your respective States, will keep this in mind. If it is agreeable to you, we can, no doubt, work out a mu-
tually satisfactory program of well-controlled tests, without endangering the status of other herds, for further testing the efficacy of a single treatment for psoroptic cattle scabies eradication, the same as was done in the case of psoroptic sheep scabies.

SUMMARY AND CONCLUSIONS

(A) An outbreak of psoroptic cattle scabies in the West afforded the first opportunity to test BHC as a miticide at a concentration of 0.075 per cent gamma isomer in unheated water and applied twice at a 10- to 14-day interval. The results obtained thus far are highly encouraging. Examinations to be made during this fall and winter of any treated cattle that have been retained on farms in areas involved will determine finally whether or not the 1954 outbreak of scabies was eradicated.

(B) The results of two rather limited tests to determine the effectiveness of a single spraying with 0.075 per cent gamma isomer of BHC on cattle showing advanced lesions and an abundance of mites, were encouraging and indicative, but cannot yet be considered conclusive. The time interval of 30 and 42 days that elapsed between spraying and subsequent examinations of the cattle was too short to be entirely conclusive. The residual effectiveness of BHC on the skin from a single spraying apparently was continued sufficiently long to result in eradication in at least the two experimental single treatment test groups of infested cattle. However, a second spraying two weeks later could be expected to further extend the period of residual effectiveness with the added assurance of destruction of any possible late hatching mites.

(C) The dipping vat still remains the method of choice for applying scabies treatments. Spraying is, however, the next best method of applying this miticide, especially where no dipping vat is available and where only small herds of cattle are to be treated. Four to eight gallons of spray liquid should be used to thoroughly saturate cattle one year and older. Two sprayings are presently recommended which also provides the added safeguard of two separate chances instead of one of getting each animal completely wet.

(D) The fact that the exact origin of some of the isolated outbreaks of scab early in 1954 could not be definitely determined leads to the belief that we might expect future outbreaks to occur at presently unforeseeable locations. I have in mind those States in which the exact origin of certain herd infestations remained undetermined according to information made available to me.

DISCUSSION OF DR. KEMPER'S PAPER

PRESIDENT GREEN: We will ask if there are any questions from the audience.

VOICE: President Green, I would like to ask Dr. Kemper a question.

Doctor, you have been dipping cattle and sheep for nigh onto 100 years now [laughter], and it is quite a privilege for us to get the value of some of your many years of experience.

I would like to ask you if you feel it is advisable or desirable or safe to dip sheep in the winter; if so, what recommendations would you make? How would you do it?

DR. H.E. KEMPER: I would have no hesitancy in dipping them in the winter, because personally I have dipped any number of them, unintentionally, however, and
have had a 'norther' come up and before long icicles were frozen on the sheep from the drainage of the wool.

The first year that occurred we were unfamiliar with the procedure. That was nearly forty years ago. We let them lie down in a corral, and unfortunately we had to chop a lot of them loose from the ice that formed under them.

Later, however, in repeating it, we learned that if we could keep the animals moving for a few hours they would dry off. I believe it is superior to putting them in a steaming barn. I think it is better to keep them out in the open and keep them moving until they dry off. I doubt if you will experience any difficulty whatever.

Before going any further, let me say that you should not warm the water above 80 degrees. Merely take the chill off it, because the reaction is far greater in hot water than it is in cold or cool water.

I would have no hesitancy at any time, if the sheep are infested—and of course time is essential because they lose flesh very rapidly—and I would certainly dip them at any reasonable time during the winter.
THE SWINE KIDNEYWORM, *STEPHANURUS DENTATUS*

*Beltsville, Maryland*

**INTRODUCTION**

The purpose of this paper is to summarize briefly some of the main facts relative to the swine kidneyworm that have been accumulating during the past several years, including (1) the life cycle and related facts, (2) the geographical distribution and prevalence of the parasite, (3) the economic losses that may be attributed to it, and (4) the problem of control.

**THE WORM AND ITS LOCATION IN THE BODY OF THE SWINE HOST**

The kidneyworm of swine is a thick, black and white nematode, about one to two inches long. The sexually mature worms occur primarily in cysts or pockets in the walls of the ureters. Each cyst is connected with the lumen of the ureter by a short fistula, which serves as an avenue of escape for eggs deposited by female worms within the cysts. Occasionally mature kidneyworms are found in the kidney tissue proper. Immature kidneyworms occur principally in the liver, their presence therein being associated with characteristic areas of cirrhosis. They occur also in various blood vessels, especially those of the liver, free in the abdominal cavity, embedded in the perirenal fat, the loin muscles, the lungs, and elsewhere.

**LIFE CYCLE**

The life cycle of the swine kidneyworm is quite complex and in some respects rather bizarre. In general, the various stages may be summarized as follows: (1) Production of the characteristic, incompletely developed eggs by females located in the urinary tract of the pig; (2) elimination of the eggs with the urine; (3) embryonation and subsequent hatching of the eggs on soil, followed by growth of the free-living larvae through two preinfective stages to the stage where they are infective to swine; (4) entrance of the larvae into the body of the pig; (5) a period of development in the liver, and (6) subsequent migration of immature worms to the urinary tract where growth to sexual maturity is completed. Facts relative to the various stages will be discussed briefly.

**The eggs:** The eggs are dark in color, about 90 to 115 microns long by 43 to 65 microns wide (1). After being deposited by the mature female worms, the eggs, intermixed with varying amounts of pus from the cysts, are carried to the urinary bladder where they accumulate until eliminated with the urine at the time of micturation. When so eliminated, the eggs usually are in the early stages of segmentation, the contents consisting of about 32 to 64 cells, or blastomeres. As many as 700,000 to 1,000,000 eggs have been observed in the urine passed by an infested hog in one day (2). Thus it can be seen that the soil of premises occupied by kidneyworm-in-
fected swine may be teeming with the eggs, each of which is potentially capable of producing an infective larva.

In view of the number of eggs that may be deposited on soil by even a single parasitized animal each day, it is fortunate that the eggs are rather readily destroyed by sunlight, drying, low temperatures and moderate degrees of heat. For example, it has been reported that eggs on dry soil exposed to direct sunlight were destroyed in about 15 minutes (3); eggs on dry soil not exposed to sunlight died in about ten hours (4). When cultured at temperatures of 30° to 33°F., the eggs failed to survive longer than about 24 hours (5); at a temperature of about 98°F. they not only failed to hatch, but degenerated within a period of six to thirty-three hours (3). Given a favorable temperature, shade and an adequate supply of moisture, the eggs on soil generally hatch within about 24 to 48 hours; within three to five days thereafter, the larvae have completed development to the infective stage.

The infective larvae: Infective larvae are microscopic in size, each being enclosed in a sheath, which is the incompletely shed cuticle from a previous molt. This sheath serves, no doubt, to protect the larva, to a certain extent from sunlight and drying. The extent to which the infective larvae are sensitive to sunlight and drying is illustrated by the following facts (4):

1. Larvae in water exposed to direct sunlight under conditions where the temperature of the water did not exceed 77°F., died in about one hour.
2. On moist soil exposed to direct sunlight, they failed to survive longer than about 15 minutes.
3. On dry soil not exposed to sunlight, none survived longer than about 10 hours.

As regards the longevity of the larvae on soil, it has been reported that on experimental grass plots protected from sunlight and drying they lived about three months (4). Evidence is accumulating, however, that on pasture the larvae may live much longer. For example, lesions due to kidneyworms were found in the livers of 80 to 97 per cent of pigs kept during the suckling and growth periods on premises that had not been occupied by swine for about six months. The pigs in question had been farrowed by sows, the urine of which was negative for kidneyworm eggs just prior to farrowing, and also at termination of the suckling period (unpublished data by one of us—J. S. A.).

Field observations relative to the distribution and behavior of the infective larvae on pastures in south Georgia during the years 1929 to 1931, brought to light some interesting facts as follows (4):

1. In general, the infective larvae were found in greatest numbers on moist soil beneath accumulations of corn husks, velvet bean straw and other debris covering areas where hogs customarily were fed. The moist soil beneath the debris apparently constituted a culture medium favorable to hatching of the eggs and their subsequent development to infectivity.
2. The larvae were never recovered from wallows, but were found to be widely distributed over pasture areas. Following heavy dews, many infective larvae on the soil of pastures migrated up the grass, and it generally was possible to recover them from grass clipped from the contaminated areas before sunrise, while the grass was still wet. On the other hand, grass clipped from the same areas in the middle of the day or during the afternoon, when the dew had evaporated, yielded only an occasional larva. These findings were confirmed by direct microscopic examination of grass from experimental plots on which eggs and/or larvae had been placed. The migration of the
larvae upward onto moist grass undoubtedly is a potent factor in the spread of this parasite among swine grazing on infested pastures early in the morning, when the grass is wet with dew.

*Mode of infection:* It has been recognized for many years that swine could become infected with kidneyworms by swallowing the infective larvae along with feed and water (5). In 1931 it was demonstrated experimentally that the larvae can penetrate the abraded skin of pigs (6). In later investigations it was found that when infective larvae were placed in contact with the intact skin of pigs and held tightly there by a layer of moist soil or even a pad of cloth, penetration of the larvae through the skin was readily accomplished (7). If pigs lie on soil contaminated with the infective larvae, ample opportunity would be afforded, therefore, for the larvae to penetrate those portions of the skin in intimate contact with the soil. Infective kidneyworm larvae are stimulated by warmth (4), the heat of the pig’s body serving apparently to stimulate and attract them. The close contact of the skin with the soil would provide a foothold for the larvae and enable them to effect entrance into the skin.

*Routes of migration of kidneyworms within the body of the pig:* Once within the body of the pig, kidneyworm larvae make their way to the liver, presumably by way of the portal circulation. Once within the liver, the larvae may remain there for a considerable period, during which they develop into macroscopically visible, but sexually immature worms. During the time spent in the liver, the young worms migrate extensively through the parenchyma, the mechanical disruption of the tissues, possibly coupled with the action of toxic substances elaborated by the worms, resulting in formation of characteristic areas of scar tissue. Ultimately the developing worms reach the surface of the liver, perforate the capsule and migrate through the body cavity toward the kidney region. In experimentally parasitized pigs this migration may begin about three months after infection. During their journey through the body cavity, the young worms often penetrate various organs and tissues. In naturally infected swine, it is not uncommon to find kidneyworms embedded in the pancreas, the mesentery, the lungs, the diaphragm, the psoas muscles, the muscles of the hams and loins, and even in the spinal canal. As regards the worms that from time to time occur in the hams, loins and spinal canal, it is problematical whether they arrived there during migration from the liver to the kidneys, or whether they developed from larvae carried by the blood stream to these places soon after infection. In the case of several pigs that had been fed massive numbers of larvae and died about a month after infection, living microscopic larvae, developed somewhat beyond the stage at which they were administered, were recovered from the spinal cord, the brain, the loins, the psoas muscles, the legs muscles and from the walls of the ureters (unpublished data by one of us—L. A. S.). Whether these larvae would in time have developed to maturity without first migrating through the liver is problematical.

*The prepatent period:* The prepatent period, which is the period between infection and the first appearance of eggs in the urine of the host, is considered to be about six months. Evidence is accumulating, however, that, in some cases at least, it may be longer. In a series of urine examinations involving a large number of brood sows kidneyworm eggs were practically never found in the urine of those less than about two to three years old. Furthermore, the highest incidence of the parasite, as deter-
mined by the presence of eggs in the urine, was found in animals six to seven years old (unpublished data by one of us—J. S. A.). Whether the noticeably predominant occurrence of patent infections in these aged animals is a manifestation of the fact that the kidneyworm is really a parasite of older swine, or whether the prepatent period is much longer than, commonly supposed, is conjectural.

One of the limiting factors in investigation of the swine kidneyworm relates to the difficulty of procuring patent infections by experimental administration of infective larvae to pigs. In the experience of the senior author, mature kidneyworms were never recovered from any of a large series of pigs so infected, and subsequently maintained in isolation for as long as two years, under rigid conditions of sanitation designed to preclude extraneous infections (2). In all cases, however, characteristic lesions were present in the liver at necropsy. This fact suggests that there may exist avenues of infection of swine with kidneyworms other than the oral or percutaneous routes. One possibility is that some invertebrate may, under certain conditions, serve as carrier of the infective larvae.

**DISTRIBUTION AND PREVALENCE**

The swine kidneyworm has a more or less world-wide distribution, being most common in regions having a tropical or subtropical climate. It is said to be common in swine in the Philippine Islands (8), Hawaii (9), Australia (3), Brazil (10), and in most Central American Countries. In the United States it is most prevalent in the South. Reports of the incidence of the parasite in farm-raised pigs in this area range from about 94 per cent (11) to about 78 per cent (12). In recent years it has been learned that the kidneyworm has spread to other sections of the country, also. Examinations of livers of hogs coming to slaughter in a large meat packing establishment in Chicago revealed the presence of lesions believed due to kidneyworms in about 40 per cent of those examined. Lesions due to kidneyworms have been seen in livers of swine that originated in Massachusetts, Kansas, Nebraska and Central Washington, also (unpublished data by one of us—L. A. S.).

**ECONOMIC LOSSES DUE TO KIDNEYWORMS**

The swine kidneyworm, because of the economic losses it causes, is considered by investigators and swine raisers to be a very important limiting factor in economical swine production in those areas where it is common. As in the case of other parasites losses caused by kidneyworms may be classified into two main categories. One relates to those losses which occur as a result of deaths from gross parasitism and the more insidious losses resulting from retarded growth and increased amounts of feed necessary to bring the parasitized animal to market size. The other involves losses which result from lowered market prices which have their origin in expected condemnations, under meat inspection procedures, of edible parts of carcasses because of the presence of the worms and associated lesions. Under Federal and equally competent State and local meat inspection, organs and tissues of swine that exhibit evidence of invasion by kidneyworms, are considered unfit for food and are condemned either in toto or are trimmed to remove the damaged portions.

The extent of losses from retarded growth of pigs infected with kidneyworms is not precisely known. It has been reported, however, that pigs experimentally infected
with this parasite grew about five-tenths of a pound less per day, on the average, during the entire growth period, than did uninfected littermates (13).

As regards condemnations under meat inspection procedures of edible parts of carcasses because of kidneyworms, two examples will serve to illustrate the extent of these losses. During the period of one week in 1929, records were kept of the amount of liver tissue condemned because of kidneyworms in a meat packing establishment in one of the Southern States (14). During that period, 5,308 hogs were slaughtered. The total weight of livers condemned because of kidneyworms amounted to 15,914 pounds, with only 572 pounds, about 4 per cent of the total, being salvaged for food. During 1951, records were kept in three meat packing establishments in one of the Southeastern States (12). During that time 277,852 hogs were slaughtered. The total weight of liver tissue condemned because of invasion by kidneyworms was estimated to be 560,750 pounds, with about 272,766 pounds, about 30 per cent of the total, being salvaged for food.

CONTROL

Control of the swine kidneyworm is a difficult problem that has vexed investigators and stockmen for many years. Treatments are without effect on the worms. Theoretically, in view of the demonstrated susceptibility of kidneyworm eggs and larvae to sunlight and drying, it should be relatively easy to devise a scheme of management by which pigs could be raised free of the parasite. Dissemination of kidneyworms is, however, so closely linked with established swine husbandry procedures that control becomes difficult in actual practice. During the past decade or so, schemes for the control of kidneyworms in Australia (3), the Philippine Islands (15), and Hawai‘i (16) have been devised. None of the procedures advocated is entirely applicable to swine husbandry practices in this country. Several years ago a scheme of sow and pig management applicable to conditions existing in southern United States, was devised, the measures being based on the demonstrated susceptibility of kidneyworm eggs and larvae to sunlight and drying (2, 4, 17). That the system recommended can be effective in preventing infection of pigs with kidneyworms, if followed in its entirety, is attested by the fact that in the case of twenty-one farm herds that were handled strictly in accordance with the provisions recommended, all livers were passed for food and the kidneys and kidney fat of all the animals were free of worms. In spite of the demonstrated effectiveness of the program, it has not met with universal approval of swine raisers, probably because of the extra work involved.

The possibility of destroying kidneyworm larvae on pasture by means of chemicals has received but little attention. In 1943, it was found that treatment of small experimental plots with methyl bromide, applied according to standard recommendations, destroyed kidneyworm eggs therein (18). Treatment of soil with this chemical is applicable only to areas such as small pens, however, since it involves keeping the soil covered with paper for 24 hours after application of the chemical.

More recently it was reported that commercial benzene hexachloride and the delta isomer destroyed preinfective kidneyworm larvae in vitro (13). The effectiveness of this chemical in destroying infective kidneyworm larvae on soil is unknown. In 1953, it was reported that polyborate, a mixture of sodium pentaborate
tetrahydrate and sodium tetraborate pentahydrate, applied dry or in solution to soil at the rate of five pounds of the chemical per 100 square feet, destroyed kidneyworm larvae on small experimental plots (19). This chemical has the very marked disadvantage, however, of being injurious to vegetation and therefore would not be suitable for use on pastures.

The fact that kidneyworm infected swine may not void the eggs with their urine until they are two to three years old seems to offer a basis for control and perhaps eradication of this parasite. Some swine producers raise their pigs from gilts or young sows, sending the breeding females to market before they are two years old, in some cases. From the standpoint of kidneyworm control, this appears to be a sound practice, which, if rigidly followed, might, in time, eliminate kidneyworms from a herd.

Probably no single measure will ever be effective in controlling the swine kidneyworm, however, all things considered. In any scheme of control involving management, it will be imperative that advantage be taken of the susceptibility of the eggs and larvae to sunlight and drying. Such measures, coupled with pasture rotation and keeping the breeding stock as free of kidneyworms as possible, through elimination from the herd all animals older than about three years, apparently, at this time, offers the best promise of controlling this troublesome pest.

REFERENCES


REPORT OF COMMITTEE ON PARASITIC DISEASES

Benjamin Schwartz, Beltsville, Md., Chairman; Wm. Schwab, Des Plaines, Illinois; John Milligan, Auburn, Alabama; Ray L. Cuff, Kansas City, Missouri; Donald W. Baker, Ithaca, N. Y.; F. R. Koutz, Columbus, Ohio; Edward G. Batte, Haddonfield, N. J.; D. F. Eveleth, Fargo, North Dakota; F. E. Hull, Lexington, Kentucky

During the year the United States Department of Agriculture published a document entitled "Losses in Agriculture, a Preliminary Appraisal for Review", which certainly merits careful consideration by this Association. So far as is known to this Committee, this is the first attempt to bring together as reliable estimates as possible regarding the annual losses in agriculture, based on a ten-year period (1942-1951). The Committee on Parasitic Diseases is confining its report, therefore, to a brief summary of the essential facts regarding the losses to the livestock industry from parasites and parasitic diseases, as given in the above-mentioned report.

The Department committee and others engaged in compiling the report stated that the estimates given therein are incomplete because there was no opportunity to undertake field surveys to obtain new data. The compilers worked out as reliable and well-documented estimates as permitted by the data. When no data were available—and this was often the case—the estimated losses represented the best judgment of the specialists who computed them. It should be recognized at the outset that estimated losses based solely on judgment, or with but little scientific survey data as a basis, cannot be considered as a substitute for factual information. Therefore, there is need, in the first place, for establishing machinery for gathering accurate information on livestock losses and, in the second place, to interpret any estimates unsupported by data, by whomever made, with caution and healthy skepticism. Another point to be borne in mind is that the financial losses assigned to the various causes do not necessarily mean in all cases financial losses to the farmer. However, the loss from the destruction of food supplies is serious from a national standpoint, regardless of whether price changes result or not. Therefore, the losses given in the report should be construed as losses to the nation, if not in all cases to its farmers.

LOSSES FROM INTERNAL PARASITES

About 300 kinds of internal parasites are involved in the losses from parasites and parasitic diseases. Some of these parasites are very common, whereas others are more or less rare. Few animals are ever entirely free from parasites, and many are hosts to thousands of these marauders. As many as a dozen or more injurious species may occur in one host animal.

Losses occur in animals of all ages, but are heaviest in young animals. Also, losses from parasites occur in all parts of the country and in all seasons but, in general, warmth, moisture, and shade favor the spread of parasites and parasitic diseases. Therefore, control measures must take into consideration the destructive effects of unfavorable climate in the case of parasites which have a free-living existence alternating with a parasitic one, and in cases involving intermediate hosts which also
may be influenced by climate. Although mortality losses of breeder, or farm, stock and of stock produced for market are sometimes heavy because of the inroads of parasites, the greatest losses are due to morbidity, including reduced health and depreciation of animal products; condemnation of carcasses or parts under Federal or other meat inspection; reduced quality of animals, including lowered grades of market stock and therefore reduced sales value; waste of feed, labor, and space to bring animals to productive or useful maturity, or to market; interference with breeding or production; lowered efficiency of work animals, such as horses and mules; abandonment of production; inefficient utilization of pastures, barns and pens by unproductive stock; lowered resistance of infected stock to other diseases and parasites; expenditures for worthless and inefficient drug treatment and equipment, and, probably, many others. In addition to the causes of losses already enumerated, expenditures for drug treatment, for the prevention, control and the eradication of parasites, and money spent to prevent parasite introduction as well as the cost of other regulatory services in connection with parasite control and eradication, must be charged as losses incurred.

Recent years have witnessed increasing instances of disease outbreaks due to parasites, characterized by severe morbidity and mortality. But even more important than these readily-apparent losses from parasitisms are the unspectacular ways in which these marauders have a marked impact on the livestock industry. Because they occur practically everywhere and are unseen, as a rule, their effects are often inapparent. Internal parasites may undermine the health of thousands of food animals and be a hazard to production, without the owners being even aware of it. There is no way in which hidden losses can be adequately estimated or even fully comprehended.

The losses from internal parasites of the various classes of farm animals and poultry are given in the tables (tables 1, 2, 3 and 4) which show the principal cause of the loss, the value thereof in dollars, and the percentage of total loss of production. The total loss per year to livestock and poultry due to internal parasites is estimated as amounting to about $430,000,000. Whether the losses among the different classes of livestock, as given in the tables, are properly apportioned is, of course, open to question. In the opinion of this Committee, the total loss is, if anything, underestimated, although the distribution of the losses among the different classes of livestock probably could stand revision.

**LOSSES FROM ARTHROPOD PARASITES**

The arthropod, or external, parasites, in common with those that live inside the body, are widely prevalent in all classes of livestock and poultry. Although their abundance varies from season to season, and may vary from year to year, livestock and poultry are seldom free of them.

The arthropod parasites that were considered in estimating the economic losses include ticks, mites, screwworms, house flies, stable flies, horse and deer flies, cattle grubs and other parasitic maggots, and lice. In general, these pests, when present in sufficient numbers, cause unthriftiness and lowered productivity because of the energy expended by the affected animal in fighting them and also on account of reduced grazing. In addition, some of the external parasites damage hides, others
### PARASITIC DISEASES

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**TABLE 1**

*Losses to Cattle from Internal Parasites*

<table>
<thead>
<tr>
<th>Cause of Loss</th>
<th>Value (1,000 dollars)</th>
<th>Percentage of Production Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coccidiosis</td>
<td>10,000</td>
<td>0.291</td>
</tr>
<tr>
<td>Gastroenteritis</td>
<td>13,624</td>
<td>0.395</td>
</tr>
<tr>
<td>Liver flukes</td>
<td>3,560*</td>
<td>0.106</td>
</tr>
<tr>
<td>Tapeworm and bladderworms</td>
<td>58†</td>
<td>0.002</td>
</tr>
<tr>
<td>Trichomoniasis (bovine genital)</td>
<td>750</td>
<td>0.022</td>
</tr>
<tr>
<td>Worm parasites</td>
<td>8,989</td>
<td>0.261</td>
</tr>
<tr>
<td>Other parasitic diseases</td>
<td>377†</td>
<td>0.011</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>37,358</strong></td>
<td></td>
</tr>
</tbody>
</table>

* Includes a loss of $1,831,150 in meat.
† Represents loss in value of meat only.

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**TABLE 2**

*Losses to Sheep from Internal Parasites*

<table>
<thead>
<tr>
<th>Cause of Loss</th>
<th>Value (1,000 dollars)</th>
<th>Percentage of Production Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coccidiosis</td>
<td>1,206</td>
<td>0.451</td>
</tr>
<tr>
<td>Gastroenteritis, parasitic:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animals</td>
<td>22,729</td>
<td>7.87</td>
</tr>
<tr>
<td>Wool</td>
<td>4,568</td>
<td>3.19</td>
</tr>
<tr>
<td>Liver flukes</td>
<td>4,650*</td>
<td>1.718</td>
</tr>
<tr>
<td>Lung worms:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animals</td>
<td>1,552</td>
<td>0.580</td>
</tr>
<tr>
<td>Wool</td>
<td>459†</td>
<td>0.332</td>
</tr>
<tr>
<td>Nodular worms:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animals</td>
<td>6,531‡</td>
<td>2.396</td>
</tr>
<tr>
<td>Wool</td>
<td>1,812‡</td>
<td>1.294</td>
</tr>
<tr>
<td>Tapeworms</td>
<td>619§</td>
<td>0.232</td>
</tr>
<tr>
<td>Other parasites</td>
<td>200</td>
<td>0.075</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>37,487</strong></td>
<td></td>
</tr>
</tbody>
</table>

* Includes a loss of $223,000 in meat.
† Includes some mortality losses.
‡ Includes a loss of $518,000 in meat.
§ Represents loss in value of meat only.
TABLE 3
Losses to Hogs from Internal Parasites

<table>
<thead>
<tr>
<th>Cause of Loss</th>
<th>Value</th>
<th>Percentage of Production Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kidney worms</td>
<td>72,772*</td>
<td>2.05</td>
</tr>
<tr>
<td>Parasites, internal</td>
<td>78,539</td>
<td>2.229</td>
</tr>
<tr>
<td>Parasites, unclassified</td>
<td>1†</td>
<td>-</td>
</tr>
<tr>
<td>Red worms</td>
<td>10,476</td>
<td>0.301</td>
</tr>
<tr>
<td>Roundworms, large intestinal</td>
<td>49,814†</td>
<td>1.414</td>
</tr>
<tr>
<td>Threadworms, intestinal</td>
<td>25,912</td>
<td>0.74</td>
</tr>
<tr>
<td>Whipworms</td>
<td>13,171</td>
<td>0.378</td>
</tr>
<tr>
<td>Worms, nodular</td>
<td>26,041§</td>
<td>0.744</td>
</tr>
<tr>
<td>Total</td>
<td>276,726</td>
<td></td>
</tr>
</tbody>
</table>

* Includes a loss of $6,396,100 in meat.
† Represents loss in value of meat only.
‡ Includes a loss of $451,416 in meat.
§ Includes a loss of $1,100,000 in meat.

TABLE 4
Losses to Poultry from Internal Parasites

<table>
<thead>
<tr>
<th>Cause of Loss</th>
<th>Value</th>
<th>Percentage of Production Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackhead:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chickens</td>
<td>149</td>
<td>0.005</td>
</tr>
<tr>
<td>Turkeys</td>
<td>3,815</td>
<td>1.566</td>
</tr>
<tr>
<td>Capillarids (turkeys)</td>
<td>320</td>
<td>0.133</td>
</tr>
<tr>
<td>Coccidiosis:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chickens</td>
<td>38,229*</td>
<td>1.297</td>
</tr>
<tr>
<td>Turkeys</td>
<td>466</td>
<td>0.194</td>
</tr>
<tr>
<td>Helminthiasis (chickens and turkeys)</td>
<td>897†</td>
<td>0.028</td>
</tr>
<tr>
<td>Hexamitiasis (turkeys)</td>
<td>667</td>
<td>0.278</td>
</tr>
<tr>
<td>Intestinal roundworms (chicks and turkeys)</td>
<td>283</td>
<td>0.009</td>
</tr>
<tr>
<td>Leucocytozoan (turkeys)</td>
<td>708</td>
<td>0.294</td>
</tr>
<tr>
<td>Tapeworms (chickens and turkeys)</td>
<td>739</td>
<td>0.023</td>
</tr>
<tr>
<td>Trichomoniasis (turkeys)</td>
<td>47</td>
<td>0.02</td>
</tr>
<tr>
<td>Total</td>
<td>46,320</td>
<td></td>
</tr>
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</table>

* Includes a loss of $353,560 in eggs.
† Includes a loss of $882,000 in eggs.
TABLE 5
Losses to Livestock and Poultry Caused by Insects

<table>
<thead>
<tr>
<th>Cause of Loss</th>
<th>Value</th>
<th>Percentage of Production Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
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<tr>
<td>1,000 dollars</td>
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<td></td>
</tr>
<tr>
<td>Grubs</td>
<td>100,600</td>
<td>2.83</td>
</tr>
<tr>
<td>Lice</td>
<td>20,000</td>
<td>0.58</td>
</tr>
<tr>
<td>Horn fly</td>
<td>150,000</td>
<td>4.19</td>
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<tr>
<td>Horse and deer flies</td>
<td>75,000</td>
<td>2.14</td>
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<tr>
<td>Scabies mites</td>
<td>4,500</td>
<td>0.13</td>
</tr>
<tr>
<td>Stable fly</td>
<td>20,000</td>
<td>0.58</td>
</tr>
<tr>
<td>Ticks</td>
<td>13,800</td>
<td>0.40</td>
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<tr>
<td>Total losses due to cattle insects</td>
<td>383,300</td>
<td></td>
</tr>
<tr>
<td>Goats</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lice and mites (loss of mohair)</td>
<td>800</td>
<td>7.00</td>
</tr>
<tr>
<td>All Livestock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screw-worm</td>
<td>20,000</td>
<td></td>
</tr>
<tr>
<td>Poultry (Farm chickens and broilers)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All insects</td>
<td>80,212</td>
<td>7.0</td>
</tr>
<tr>
<td>Sheep</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bots</td>
<td>8,000</td>
<td>2.92</td>
</tr>
<tr>
<td>Ear ticks</td>
<td>1,300</td>
<td>0.49</td>
</tr>
<tr>
<td>Keds</td>
<td>7,500</td>
<td>2.74</td>
</tr>
<tr>
<td>Lice</td>
<td>1,500</td>
<td>0.56</td>
</tr>
<tr>
<td>Mites</td>
<td>2,000</td>
<td>0.75</td>
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<tr>
<td>Total losses due to sheep insects</td>
<td>20,300</td>
<td></td>
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<tr>
<td>Swine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lice and mites</td>
<td>3,100</td>
<td>0.09</td>
</tr>
<tr>
<td>Total losses to livestock and poultry due to insects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animals</td>
<td>506,912</td>
<td>†</td>
</tr>
<tr>
<td>Mohair</td>
<td>800</td>
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</tr>
</tbody>
</table>

* Including losses in milk production.
† Represents morbidity loss in value only.

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spoil meat in addition to damaging hides, and some do damage in other ways. The total loss from arthropod parasites is estimated at somewhat over $500,000,000 (table 5), which is greater than that ascribed to the depredations of the internal parasites. The total estimated annual loss due to parasites of all kinds is approximately $940,000,000, which is about one-third of the total estimated annual loss from livestock diseases and pests of all kinds.

DISCUSSION

A question may arise as to whether the apportionment of the losses to external and internal parasites, respectively, can be successfully defended on the basis of known facts, and also whether the relative apportionment of the losses to the parasitic and nonparasitic diseases has a sound basis in factual information. Again it must be emphasized that losses from parasites are in the main of the nonspectacular type, involving a large percentage of all food animals, and commonly reflected in lower weight gains of growing stock and in spoilage of animal food and fiber. Such losses, in the aggregate, may represent in the long run as heavy a toll as that exacted by the more striking and even devastating epizootics of infectious diseases. What the preliminary survey, so briefly summarized in this report, definitely points to, is this: There is an urgent need of surveying systematically livestock losses of all kinds, year in and year out, so as to secure data on which to establish a factual basis for evaluating the role of infectious, noninfectious, parasitic, nutritional, and other diseases and ailments of livestock and poultry. Moreover, reliable data on the economic impact of specific parasitisms is a necessary basis for the direction of effective research.
EQUINE ENCEPHALOMYELITIS IN PHEASANTS IN 1952-53*

J. J. Black, D. V. M.; J. A. Bivens, B. S., D. V. M. M. S.; C. B. Hudson,
B. S., M. S.; and D. C. Tudor, B. S., V. M. D.

New Brunswick, New Jersey

In a series of six papers (1-6) we have published epizootiological observations
on 20 outbreaks of equine encephalomyelitis in pheasants which occurred between
1938 to 1951. It is the purpose of this paper to record observations on five addi-
tional outbreaks in 1952 and four in 1953.

EGG HARBOR OUTBREAK, 1952

During the four years of operation, the disease made its first appearance on this
plant in 1951 (6) and killed 508 pheasants between September 15 and October 16.
From 70 female and 15 male breeders housed in two pens (Nos. 8 and 9), a total
of 1409 birds were produced in 10 hatches. The young stock was vaccinated against
equine encephalomyelitis early in July when the ages ranged from five to eight
weeks. The dose of vaccine was 0.2 cc. of a double dilution.

The first loss thought to be due to encephalomyelitis occurred in an outside pen
(No. 10) on August 18. Later, other pens (Nos. 1, 2, 3, 4, 6 (inside), and 9 (breeders)
sustained losses. Of the pens in which losses occurred, the only one outside was
No. 10. Five pens (Nos. 11, 12, 13, 14, 7 (outside) and No. 5 (inside) were spared.

The vegetation in all outside pens except No. 14 had disappeared by the time
the outbreak began. Pen 14 had no wire top so that flight of the birds therein was
prevented by plucking the wing feathers. The ducks, geese, and chickens reared on
the place were not affected, but sparrows died on the premises at the time of the
outbreak.

Unfortunately, the number of birds housed in each pen is unknown, but a loss
of 427 out of 1409 can be accounted for, of which only two occurred in the 85 breed-
ers (Table 1).

A young male was presented at our South Jersey laboratory (Case 44956) for
examination on August 19. The owner, having seen the disease the previous year,
expressed the belief that the paralytic symptoms were typical of encephalomyelitis.
The bird soon died and the brain and spleen were collected in separate tubes and
frozen. Later the samples were brought to New Brunswick, suspended in broth
and each inoculated into four ten-day embryonating eggs on August 26 after treat-
ment with antibiotics. In the brain group, one embryo died in two days and one in
the spleen group in one day. Neither was considered typical of encephalomyelitis,
but a subinoculation of each was made August 27, 1954, with negative results.

* Paper of the Journal Series, New Jersey Agricultural Experiment Station,
Rutgers University, the State University of New Jersey, Department of Animal
Pathology.

1 Communicable Disease Center, Public Health Service, United States Depart-
ment of Health, Education, and Welfare.

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<table>
<thead>
<tr>
<th>Date</th>
<th>Pen No.</th>
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<tbody>
<tr>
<td></td>
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<td>Aug. 18</td>
<td></td>
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<td>6</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>29</td>
</tr>
</tbody>
</table>

310
Losses continued with the heaviest mortality occurring in the exposed runs. Since a diagnosis had not been made on the bird presented August 19, five more birds were brought into our South Jersey laboratory (Case 45153) on September 9. Pools of brains, spleens, and tracheae were collected separately in three tubes and frozen for shipment to New Brunswick where each of the three antibiotic-treated suspensions was inoculated into four ten-day embryonating eggs on September 23. None of the embryos inoculated with the tracheal suspension died. Two of those inoculated with spleen suspension died in one and two days, respectively. A liver suspension of both embryos subinoculated on the 26th resulted in the death of two embryos in one and three days, but neither appeared typical. A third passage was not made until August 27, 1954, in which one of four embryos died on the third day. The liver of this embryo was used to initiate a fourth passage on the 31st, and all embryos lived through seven days post inoculation.

The brain suspension, however, killed two embryos within 48 hours. Cultures were negative, and a liver suspension of one of the embryos subinoculated on September 26 killed the four embryos within 24 hours. All cultures were sterile.

**Forked River Outbreak, 1952**

The disease was positively diagnosed on this premise (State Game Farm) in 1939 (2). A disastrous outbreak occurred in 1945, followed by a heavy loss in one of two nonvaccinated pens in 1946 (5).

In the 1952 season, the young cock birds were kept in the six north units of a double row of 12 units each 50 x 300 feet with 450 birds to the unit. The disease affected only one unit (No. 9) and began on October 7. These cocks were from the first hatch on May 12 so that at the time of the outbreak the affected birds were five months old and the ages of the others ranged from three weeks to five months. In order to prevent picking, debeaking was practiced at 3½ weeks and repeated at 2½ months of age. Vaccination was routinely done at six weeks of age. Neither vaccination nor debeaking was done after the disease appeared. The occupied runs were devoid of vegetation. Sparrows and other wild birds were plentiful in the area. A frost occurred on October 25.

The early losses in the stricken pen were considered as flight casualties, but by October 14 the first symptoms suggestive of encephalomyelitis (drowsiness, partial and/or complete paralysis) were observed, and five cock birds were presented for examination (Case 38505).

The autopsy of a paralyzed bird was negative except for a few cecal worms. The brain of this bird was collected aseptically. The cranial cavities of the other four birds were merely opened to permit the collection of a pooled sample.

No antibiotics were used in either sample inoculated the day of collection. Of the four ten-day embryonating eggs inoculated with the single brain suspension, three died within 24 hours and the fourth within 48 hours. The embryos were typical and cultures were sterile. The pool of four brains was apparently contaminated as evidenced by the cultures of the embryos which died within 24 hours but which were typical otherwise. The livers of two were suspended in about 2 cc. of broth and to 1 cc. of the supernatant 0.2 cc. each of penicillin and streptomycin (20,000 units and 20 mgs.) were added about 20 minutes prior to inoculation on
October 17. The four embryos died within 24 hours, were typical and bacteriologically sterile.

The daily mortality from October 7 to the 30th is given in Table 2.

**CHESTER OUTBREAK, 1952**

The first outbreak on this farm occurred in 1951, and, curiously enough, was confined to two pens (6). This year, the disease appeared about October 6, and up to the time specimens were presented it had been confined to the 850 birds in the same two pens affected in 1951. The mortality in this population of 850 birds from October 6 to the 16th had been 85. The population of the whole farm was 3600, and the stricken birds were 20 weeks old at the time of the attack. According to the owner, adult mosquito activity was markedly reduced at the time of the outbreak, probably because of two frosts, one occurring approximately four days prior to the outbreak and the other on or about October 14. The premises were heavily populated with rats.

Four cocks, two of which were paralyzed, and two females were presented on October 16 (Case 38525). On autopsy, no gross lesions were observed. A pool of a small portion from each of the six brains was suspended in broth and 1 cc. of the supernatant treated with antibiotics (20,000 units penicillin and 20 mgs. streptomycin) for inoculation on October 17. The four embryos were dead within 24 hours, appeared typical on harvest, and were bacteriologically sterile.

**SUSSEX OUTBREAK, 1952**

Pheasants had been reared on this farm for ten years by the owner’s son as a 4H project without an outbreak even suggestive of encephalomyelitis. In 1952, the disease attacked a pen of 400 birds about October 13 and killed about 40 by October 23. Three other pens containing about 1600 birds had not been affected during this period. Most of the affected birds were hens in a ratio of about three to one. Migrant ducks and geese had been seen in the area during the last ten days.

The two hens presented October 23 (Case 38581) showed leg paralysis but were alert otherwise. These showed no gross lesions on autopsy and the third bird, a
cock, showed ecchymosis on the heart and some congestion of the liver. The usual pool of bits of brain removed from each bird by means of a capillary pipette was suspended, treated with antibiotics (10,000 units of penicillin and 10 mgs. of streptomycin per cc. of supernatant), and inoculated on October 24 into four ten-day embryonating eggs in a dose of 0.2 cc. per egg. Two embryos died within 48 hours and the other two within 72 hours. In the second passage the inoculum consisted of a suspension of two livers, both sterile on harvest, but treated with a double dose of antibiotics. Of the five embryos inoculated, four died within 24 hours and the fifth within 48 hours. They were typical in appearance and bacteriologically sterile.

**WALDEN, ULSTER COUNTY, NEW YORK, OUTBREAK, 1952**

This case was referred to us through the courtesy of Dr. C. I. Angstrom of the Regional Poultry Disease Laboratory of Kingston, New York, under his number 8837–51486. The first consignment of three birds was presented to him on October 23, 1952. The history obtained by Dr. Angstrom revealed that the owner reared pheasants commercially. All birds were hatched on the premises from breeders purchased in Southeast Connecticut in October–December, 1951.

The disease apparently began in a pen containing about 400 birds in August. The primary symptom was leg weakness. The birds tended to crouch or lie on the side. When disturbed, they were able to fly a short distance. The loss was about 20 during a two-week period. Both males and females died, but the survivors showed no residual signs on recovery.

Pen 2 became affected about October 15, and individuals were rarely ill more than three to four days before death. About 14 of 150 died in ten days. They were 15½ weeks old.

Pen 3 contained about 200 birds, of which 15 died.

Pen 5 was next attacked, and about 50 of the 300 died.

Pen 4 contained about 400 birds, of which about 100 died. During the growing season these were judged to be the best birds.

Pen 1 consisted of about 100 culls from several hatches. This pen never contracted the disease.

Pens 5 and 6 were large and contained the first hatches. Presumably then, Pen 6 is the first pen described above; that is, the one containing 400 birds.

Autopsy of the three birds presented October 23, 1952, revealed no gross lesions. A tentative diagnosis of Newcastle disease or equine encephalomyelitis was made because, of the two live birds, both showed leg weakness and in one, the head and neck were twisted back and to the side. An HI test on the live birds when presented and a second test on one of them later failed to give a positive reaction for Newcastle disease.

A second consignment of three birds, about 15½ weeks old, was brought in November 6 and the brains removed to separate tubes. Because of suspicions that his premises might be quarantined, the owner was reluctant to give additional information. It is not known from what pen or pens the three birds came. Doctor Angstrom visited the place in early December and learned that the survivors had
been sold to hunt clubs and the pens filled with purchased birds in which there had been no unusual losses.

The three brain samples were submitted to us January 14, 1953 (Case 39105). Each was suspended in broth, treated with antibiotics (10,000 units of penicillin and 10 mgs. of streptomycin per cc.) and inoculated into four ten-day embryonating eggs on January 16, 1953. The four eggs inoculated with brain 3 suspension lived and were discarded after seven days of incubation. Brain 2 suspension caused one death in 48 hours of four eggs inoculated. A liver suspension of this embryo killed one of four embryos in 24 hours in the second passage, and in the third passage one of five embryos in 24 hours. The embryos were sterile but not typical in appearance. Brain 1 suspension killed only one embryo within 48 hours of four inoculated. The sterile liver suspension of this embryo killed the four embryos of the second passage within 24 hours, and a liver suspension of one of these duplicated the results in the five eggs of the third passage. All embryos of the second and third passages were typical in appearance and sterile.

NEW GRETNA OUTBREAK, 1953

Yearly outbreaks were diagnosed on this farm by virus isolation in 1943, 1944, 1945, and 1946 (4, 5). Although these were the only outbreaks from which birds were submitted for examination, the owner believes that the disease has occurred every year since the initial outbreak.

At the time of the present outbreak, the population consisted of 24 yearling breeders and 95 young birds. The breeders were housed in five pens 15 feet x 15 feet with one male and three or four females in each. Two of these (I and II) were situated approximately 200 feet from the remaining three (III, IV, and V) which were contiguous with a group of seven pens, each containing a flock of domestic Mallard ducks, pigeons, or young pheasants. Twenty of the younger pheasants were reared in a 15' x 30' pen (Pen VI), the remaining 75 in Pen VII, approximately 40' x 165'. A distance of approximately 30 feet separated the pens housing breeder flocks III, IV, and V from the pens containing the young birds. The two flocks of young pheasants were collected together in Pen VII on September 2.

The flock was considered healthy except for occasional cannibalism and feather picking in the breeders.

The first wave of the disease affected the breeders only and lasted from August 17 through August 24. In this period, 11 cases, of which one cock recovered, were observed in Pens I, II, III, and IV. The first case did not appear in the young stock until September 21 for a total of five to September 27.

One breeder hen and a pool of portions of brain from two adult birds collected August 23 were presented August 24 (Case 41616). The hen was thin and showed an injury in the breast and crop, a picked vent and a large hemorrhage on one cerebral hemisphere. The birds represented in the pool were in good flesh and showed no gross pathology.

The single sample and the pool were suspended in broth separately with the usual antibiotic mixture and inoculated into embryonating eggs on August 25. The single brain suspension killed three embryos in 24 hours and one within 48 hours.
The five embryos inoculated with the other suspension were all dead within 24 hours. The embryos were typical and all cultures were sterile.

After the disease appeared in the young stock, portions of brain from two birds were pooled and presented on September 28. The material was suspended in the usual manner and inoculated into four embryos on October 2. These died in 1, 2, 2, and 7 days, respectively. The liver of a 24 hour dead embryo was suspended and inoculated on October 9, and the four embryos died within 24 hours. All embryos were typical and cultures of each were sterile.

**MAYS LANDING OUTBREAK, 1953**

Pheasants have been reared on this farm from 1938 to 1943 and for the period from 1949 to the present. The first outbreak occurred in 1940 and was confirmed by virus isolation (3). Although no birds were submitted for examination, the owner believes that annual visitations occurred until 1943 when rearing was discontinued because of the heavy losses. However, when rearing was started in 1949 the disease reappeared each year, according to the owner, although the losses were only occasional in 1952.

The physical plant consisted of three contiguous breeder houses (A, B and C) each 12’ x 16’, of which about 48 sq. ft. were sheltered. A second unit set apart consisted of nine contiguous brooder units (1 to 9) each 5’ x 20’, of which about 60 sq. ft. made up the shelter. Apart from the above units there were two adjoining outside rearing pens (I and II) 60’ x 50’ and 50’ x 50’, respectively, aside a third pen (III) 50’ x 150’.

At the onset of the outbreak, the 32 yearling breeders were housed in breeder pens A, B and C and rearing pen III. Of the 850 young birds 304 were housed in rearing pens I and II. The remaining ones were housed in seven of the nine brooder pens.

The first paralytic birds were seen on August 27, and portions of brain from two specimens were tubed separately and brought to New Brunswick in a frozen state (Case 41655). The samples were suspended as usual, treated with antibiotics, and each inoculated into four embryoating eggs on August 28. Within 24 hours all embryos died, were typical in appearance and bacteriologically sterile.

Mortality records by two-day intervals were recorded from August 27 to the end of the outbreak October 23. Young birds from brooder pens 4, 5, and 6 were put in rearing pen III with 14 breeders on September 21. Four days later the disease appeared in the mixed population. Birds in brooder pens 1, 2, and 3 were moved to rearing pen II on October 5.

The young birds were vaccinated between July 16 and 31 when the ages varied from four to nine weeks. Cannibalism and feather picking were more prevalent on this farm than any other affected farm under observation.

Pertinent data regarding the outbreak is given in Table 3.

**EGG HARBOR OUTBREAK, 1953**

Pheasants have been reared on this farm since 1949, but the disease was not recognized until 1951 when the diagnosis was confirmed by virus isolation (6). There was a reoccurrence in 1952, as reported previously in this paper.
### TABLE 3

**Epizootiological Data Pertaining to Eastern Equine Encephalomyelitis Among Pheasants Reared on the Mays Landing Farm, New Jersey, 1963**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Rearing Pens (I and II)</th>
<th>Brooder Pens</th>
<th>Rearing Pen III</th>
<th>Brooder Pen 7</th>
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<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Population</td>
<td>304</td>
<td>90</td>
<td>90</td>
<td>80</td>
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<tr>
<td>Sq. ft. per bird</td>
<td>18.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.3</td>
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<td>Approx. age in wks., on 8/27/53</td>
<td>12-15</td>
<td>6/4</td>
<td>4-5</td>
<td>8</td>
</tr>
<tr>
<td>Date vaccinated</td>
<td>7/16</td>
<td>8/18</td>
<td>8/27</td>
<td>8/18</td>
</tr>
<tr>
<td>Approx. age in wks., when vaccinated</td>
<td>6-9</td>
<td>5</td>
<td>4-5</td>
<td>7</td>
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<tr>
<td>% vaccinated</td>
<td>88.8</td>
<td>100</td>
<td>85.5</td>
<td>100</td>
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</tbody>
</table>

**Aug.**
- 26-27: 2
- 28-29: 9
- 30-31: 23

**Sept.**
- 1-2: 22
- 3-4: 33
- 5-6: 25
- 7-8: 26
- 9-10: 22
- 11-12: 12
- 13-14: 5
- 15-16: 6
- 17-18: 1
- 19-20: 1
- 21-22: 1
- 23-24: 1
- 25-26: 1
- 27-28: 1
- 29-30: 1

**Oct.**
- 1-2: 1
- 3-4: 1
- 5-6: 1
- 7-8: 1
- 9-10: 1
- 11-12: 1
- 13-14: 2
- 15-16: 8
- 17-18: 3
- 19-20: 1
- 21-22: 2

**Total**
- 353
- 44
- 10

**Est. mortality**
- %: 62.2
- 48.8
- 62.2
- 66.2
- 31.0
- 25 Total 54.5

* Birds in Pens 4, 5 and 6 put in Rearing Pen III with 14 breeders on September 21.
† Birds in Pens 1, 2 and 3 put in Rearing Pen II on October 5.
‡ Each figure denotes mortality during a 48-hour period.
At the time of the outbreak, the population consisted of one old cock and three males and 14 females from the 1952 hatch. Approximately 213 birds were hatched from April 7 to May 19 and divided into two groups without regard to age. Group A consisted of 142 birds housed in House 1 (16' x 25') and outside pen I (25' x 50'). Group B consisted of 71 birds in House 2 (16' x 21') and Pen 2 (25' x 50'). Pens I and II were side by side, but a feed room and a vacant space separated House I from House II. On September 3, Group B was moved to House III (16' x 42') which adjoined House II but which had no outside pen. This move was made on the belief of the owner that birds indoors were less liable to infection. The outbreak actually started, however, on August 27. Then, on September 15, survivors of Groups A and B were combined in House II and its outside pen because of reduced numbers in consequence of losses.

Prior to the outbreak the birds were healthy, and cannibalism and feather picking were only moderate. Conditions were unfavorable for salt marsh breeding mosquitoes. There was, however, surface water in ponds and ditches. Wild birds and especially English sparrows were plentiful in the surrounding woods.

The owner believes that the first specific death occurred on August 23 followed by four more deaths before August 27. On this date, a bird died that was not observed to be ill on careful inspection the previous day. The bird was refrigerated overnight and a portion of its brain removed to a tube and frozen (Case 41673). The autopsy was negative. The brain was suspended on September 1, treated with antibiotics and inoculated into embryonating eggs. Three of the embryos died within 24 hours and the fourth within 48 hours. The embryos were typical and bacteriologically sterile.

In the same consignment, three birds were presented. One of the live birds showed a normal but pale spleen. There were many Capillaria sp. in the ceca. Bird 2 had apparently died in transit and showed white breast muscles characteristic of birds which die of heat in close confinement. The autopsy was otherwise negative. Bird 3 was alive and showed a few Capillaria sp. in the ceca. Individual brain samples were collected, prepared in the usual way and each inoculated into four embryonating eggs. Of the eight embryos inoculated, only one lived beyond 24 hours. They were typical on harvest and sterile. Of the four embryos inoculated with Brain 3, two died on the third day and the others were still alive on the seventh day post inoculation. In the second passage initiated with a liver suspension of one of the dead embryos, the results were negative.

The daily incidence from August 28 to the end of the outbreak September 30 is given in Table 4.

In supplementary studies on this outbreak, English sparrows and mosquitoes were trapped on the premises from the last week in August until September 10. Eastern equine encephalomyelitis (EEE) virus was recovered from two sparrow specimens and from three mosquito lots collected during this period. Details on these isolations are reported elsewhere (7).

FORKED RIVER OUTBREAK, 1953

As stated above, the disease had been positively diagnosed on this farm in 1939, 1945, and 1946 (2, 5).
TABLE 4

Daily Incidence of Encephalomyelitis in 213 Young Birds, Egg Harbor Outbreak, 1953

<table>
<thead>
<tr>
<th>Date</th>
<th>Incidence</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group A</td>
<td>Group B</td>
</tr>
<tr>
<td>Aug. 28</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Sept. 1</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5</td>
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</tr>
<tr>
<td>4</td>
<td>3</td>
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<tr>
<td>5</td>
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<tr>
<td>7</td>
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<td>8</td>
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<tr>
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<td>16</td>
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<td>29</td>
<td>1</td>
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</tr>
<tr>
<td>30</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>110</td>
<td></td>
</tr>
</tbody>
</table>

* Groups A and B combined on September 15.

The physical arrangement of this plant has already been described under the 1952 outbreak. In 1953, each of the 12 pens contained approximately 475 birds of both sexes. Only the birds in Pen 1 were affected when they were four months of age. This was an end pen on the south side. The birds had been debeaked at 3½
**TABLE 5**

*Daily Mortality in 476 Young Birds, Forked River Outbreak, 1963*

<table>
<thead>
<tr>
<th>Date</th>
<th>Mortality Pen 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept. 1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
</tr>
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<td>3</td>
<td>5</td>
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<tr>
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</tr>
<tr>
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<tr>
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<td>11</td>
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<td>13</td>
<td>28</td>
</tr>
<tr>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>131</td>
</tr>
</tbody>
</table>

**TABLE 6**

*Results of Mouse Neutralization Tests Using Ten Virus Isolates From Ring-Necked Pheasant Cases, New Jersey, 1939-1951*

<table>
<thead>
<tr>
<th>Laboratory Strain No.</th>
<th>Outbreak</th>
<th>Mouse Passage</th>
<th>LD&lt;sub&gt;50&lt;/sub&gt;</th>
<th>Neutralization Index†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>EEE immune serum</td>
<td>WEE$ immune serum</td>
</tr>
<tr>
<td>E8M2</td>
<td>Sparta, 1939</td>
<td>2nd</td>
<td>5.7</td>
<td>—</td>
</tr>
<tr>
<td>E6M2</td>
<td>New Gretna, 1943</td>
<td>2nd</td>
<td>5.3</td>
<td>8.6</td>
</tr>
<tr>
<td>E4M2</td>
<td>New Gretna, 1944</td>
<td>2nd</td>
<td>5.3</td>
<td>7.9</td>
</tr>
<tr>
<td>E15M2</td>
<td>New Gretna, 1945</td>
<td>2nd</td>
<td>5.3</td>
<td>7.3</td>
</tr>
<tr>
<td>E15M2</td>
<td>Forked River, 1945</td>
<td>2nd</td>
<td>5.6</td>
<td>7.8</td>
</tr>
<tr>
<td>E6M2</td>
<td>Salem, 1945</td>
<td>2nd</td>
<td>5.6</td>
<td>8.1</td>
</tr>
<tr>
<td>E10M2</td>
<td>Forked River, 1946</td>
<td>2nd</td>
<td>6.1</td>
<td>7.9</td>
</tr>
<tr>
<td>E10M3</td>
<td>New Brunswick, 1948</td>
<td>3rd</td>
<td>5.7</td>
<td>7.5</td>
</tr>
<tr>
<td>E4M2</td>
<td>Chester, 1951</td>
<td>2nd</td>
<td>6.0</td>
<td>—</td>
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<tr>
<td>E6M2</td>
<td>Dividing Creek, 1951</td>
<td>2nd</td>
<td>4.7</td>
<td>—</td>
</tr>
</tbody>
</table>

*Expressed as the reciprocal log of the dilution causing death in 50 per cent of the mice.*

† *Expressed as the antilog of the difference between the LD<sub>50</sub> end points of the virus in the presence of normal and immune serums.*

‡ *Western equine encephalomyelitis.*
TABLE 7
Challenge of EEE Immunized and Normal Mice with Pheasant Brain Isolates, New Jersey, 1953

<table>
<thead>
<tr>
<th>Laboratory Strain No.</th>
<th>Outbreak</th>
<th>Mortality Ratio* per Dilution of Virus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Immune mice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$10^{-2}$</td>
</tr>
<tr>
<td>NJ 1001 P-2</td>
<td>Mays Landing, 1953</td>
<td>1/5</td>
</tr>
<tr>
<td>NJ 1009 P-1</td>
<td>Egg Harbor, 1953</td>
<td>0/5</td>
</tr>
<tr>
<td>NJ 1015 P-2</td>
<td>Forked River, 1953</td>
<td>1/5</td>
</tr>
<tr>
<td>NJ 1060 P-2</td>
<td>New Gretna, 1953</td>
<td>1/5</td>
</tr>
</tbody>
</table>

* Denotes the ratio of the number of deaths (numerator) to the total number inoculated (denominator) with a given dilution of the virus. N.T. denotes that the indicated dilution was not tested.

weeks of age, vaccinated at six weeks and distributed in the pens. The outbreak lasted from September 1 to September 15 and never spread to the thousands of other birds on the premises. The birds in the other five pens on the south side were of the same age and reared by the same methods.

Portions of brains from five birds were pooled on September 4 and frozen until suspended for inoculation after antibiotic treatment on September 8 (Case 41733). Of the four embryonating eggs inoculated, one died in 24 hours and the other three within 48 hours. The embryos were typical and sterile.

The daily mortality record is recorded in Table 5.

Additional laboratory studies (7) were made to confirm further the identity of the four isolates obtained in the 1953 outbreaks and of ten obtained in outbreaks occurring from 1939 to 1951. The 1953 strains were identified by challenging EEE-immune mice by the intracerebral route and the earlier isolates by means of virus neutralization tests in three-to four-week-old mice (CFW strain) using standard methods (8). The results of these tests (Tables 6 and 7) fully supported the initial diagnoses based on clinical signs in diseased pheasants and the typical pathology produced by the agents in embryonated eggs.

DISCUSSION

. Nine additional outbreaks of eastern equine encephalomyelitis (EEE) are reported in commercially reared ring-necked pheasant flocks. These bring the total to 29 that have been diagnosed since 1939. 27 of these have occurred in New Jersey, one in Pennsylvania, and one in New York State. The diagnosis of each of the first five outbreaks was based on the recovery of the agent in embryonated eggs and its inactivation by known immune serum as demonstrated by means of in ovo neutralization tests. The characteristic behavior of EEE isolates in eggs, however, was thereafter believed to be sufficient criterion for identification. This belief has been substantiated by the results of mouse neutralization or vaccination-challenge tests on 14 additional isolates as reported in the present paper. These more com-
plete tests have in no instance failed to confirm an identification based on chick embryo pathology alone.

Although most investigators believe that mosquitoes provide the only important means of transferring EEE virus from an infected to a susceptible vertebrate host, it is suggested that certain characteristics of pheasant outbreaks are inconsistent with this hypothesis. These characteristics are summarized as follows:

(1) Proportions in excess of ninety percent of the population in an individual pen may show signs of disease. Other birds of the same age in contiguous pens may escape disease for weeks or perhaps altogether.

(2) While most outbreaks begin in August and September, a few continue into or begin in October and November, considerably later in the season than the period of perceptible mosquito activity in New Jersey. The occurrence of closed epidemics in separate pens strongly suggests that once infection is introduced in a flock, possibly by infective mosquitoes, it may subsequently be transferred by other mechanisms.

It is believed that EEE occurs with sufficient frequency to pose a serious economic problem to breeders of ring-necked pheasants in New Jersey and perhaps in other highly endemic areas. For this reason and because of its public health importance, further effort should be made to elucidate the epidemiology of EEE and to devise practical methods for its control.

REFERENCES

THE NEED FOR IMPROVEMENT OF POULTRY DISEASE VACCINES

ROBERT P. HANSON, Ph.D.

Department of Veterinary Science, University of Wisconsin, Madison

Under the present program of testing and licensing a significant portion of the poultry disease vaccines produced in the United States have continued to give unsatisfactory results. Aware of this situation, members of the state and federal experiment stations have discussed the problem at the various regional technical committee meetings on Newcastle disease. In November 1953 a special committee with four members, Doctors L. P. Johnson, Robert, P. Hanson, Arnold S. Rosenwald and Henry VanRoekel, was appointed by the interregional body to prepare a report which would consider the problem of improving the standards for vaccines.

The committee reviewed the system of manufacture and control. They found that some of the tests employed in evaluating vaccines could be improved on the basis of information now available and other tests could be improved only if more research were done. In general, the tests were not sufficiently quantitative. Finally, the committee, keeping in mind the vaccine producer, the control agencies and the research worker, reported five bases for improvement (1). They concluded that there is need to:

I. Achieve better exchange of information between the regulatory agency and the interested groups. Better cooperation between the research and regulatory branches of the state and federal governments might be attained by the creation of a representative advisory group to the Biological Products Section. Distribution of results of research and decisions especially on regulatory matters, pending and acted on, should be prompt and widespread and should include research groups at experiment stations as well as state regulatory groups.

II. Increase present standards for virus vaccines. The Biological Products Section should be authorized to increase its staff and facilities so that it might adequately and regularly test randomly selected serials of Newcastle disease vaccine and other licensed vaccines. Its staff should include such specialists as statisticians and virologists. Its facilities must include a laboratory with animal isolation units.

III. Establish a program for revision of standards. Safety and potency tests now employed should be studied and evaluated by biological and statistical methods so that they might be improved. Changes should be subject to further modifications as research warrants. Intensive research, specifically designed to improve the tests and give validity to the results, should be initiated and supported.

IV. Establish a program for evaluating new products. There is great need for study and prompt action to provide sound basis and policy for licensing new products of proved value and refusing licenses for those which have little or no merit or for which there is no real need.

V. Pay for this program by sharing the cost. To get better vaccines, we must have more research, more extension education and better production control. It will take additional expenditures by state and federal governments. It is only proper that
biological industry shoulder a proper share of the load—perhaps through a national
foundation or fund for research on animal biologics.

The present discussion will be based upon several specific problems and the
bearing they have on the recommendations of the experiment station committee.
The first problem deals with a live virus vaccine which was contaminated with an
antigenically different virus. This summer Dr. M. S. Hofstad of Iowa State College
detected the presence of Newcastle disease virus in a serial of fowl pox vaccine.
He reported the results to the vaccine producer who confirmed the finding. He
submitted a vial of the serial to us. We also found the virus. Yet, the vaccine had
passed the prescribed safety test. How could such an anomalous situation arise?
The answer may bring us closer to an understanding of several of the recommenda-
tions of the committee.

A vial of the serial was aseptically opened in our laboratory and a 1:4, 1:40,
and 1:400 dilutions prepared from the reconstituted pox vaccine. Inoculations
were made into embryonating eggs and into susceptible chickens. The embryos
inoculated were 10 days of age and they were given 0.1 ml. of the virus suspension
in the allantoic chamber. Fowl pox virus introduced by this route rarely produces
death of the embryo. Over 90 per cent of the eggs receiving both the 1:4 and 1:40
dilution of the vaccine died within four days of inoculation and one-third of the
embryos which received the 1:400 dilution died. Fluids from all of the dead em-
bryos agglutinated chicken red blood cells and this activity was inhibited specifi-
cally by Newcastle disease immune serum. Subsequent passage left no doubt that
Newcastle disease virus was present in these embryos and had been isolated from
the pox vaccine by intra-allantoic inoculation.

The chickens which had received the same inoculum intravenously, as did the
embryos developed no signs of the disease. Fowl pox virus given intravenously to
chickens seldom produces pox lesions. The sera taken from the chickens prior to
and 14 days after infection contained no hemagglutinin inhibiting antibodies.
However, sera taken 14 days after inoculation neutralized Newcastle disease virus
to high titer. Resistance to challenge by Newcastle disease virus was not tested.
The chickens, like the embryos, became infected with Newcastle disease virus
following exposure to the pox vaccine.

Further characterization of the strain of Newcastle disease virus isolated from
the pox vaccine revealed that it grew slowly in embryos, taking five to six days to
kill 9 to 10 day old embryos. Most strains of Newcastle disease virus kill in 3 to 4
days. Slow growth is a characteristic of B1 strain of Newcastle disease virus and a
few other strains. The isolate had an LD₅₀ titer for embryos of 10⁻⁴ as do most
strains of Newcastle disease virus. When chickens were exposed to the virus by
nasal installation, they remained apparently normal and when they were exposed
by intracerebral inoculation, they did not develop nervous signs. Chickens exposed
in the same manner to the B1 strain of Newcastle disease virus may also fail to
respond with any signs. The isolate was readily neutralized by specific Newcastle
disease antiserum.

What was the official test which did not reveal the presence of Newcastle disease
virus? It was simply this. A group of 15 susceptible chickens were vaccinated by
the usual method and usual dose prescribed by the producer for his product. Since the vaccine under examination was fowl pox, it was administered by wing-web puncture and the examination of the chickens was extended over a three-week period. It is quite obvious that the strain of Newcastle disease virus contaminating the product would not be revealed by such a procedure. If an approved B1 vaccine had been substituted for the pox vaccine, the presence of Newcastle disease virus in it would not have been detected by the test procedure for contamination of fowl pox vaccine.

It appears that the vaccine in question contained approximately 1000 infective units of Newcastle disease virus per ml of vaccine. It was a contaminant of very low pathogenicity for chickens and not detectable by the usual chicken inoculation test. Are contaminants not detectable in a given chicken inoculation test a hazard to the poultry industry? Should the problem be dismissed without research?

The vaccine in question contained bacterial contaminants, none of which belonged to the Salmonella group. Some of the contaminants had considerable resistance to antibiotics which were incorporated in the vaccine. They were not pathogenic for older chickens in dosages employed but minute dosages were lethal for embryos. The pathogenicity of the bacterial organisms for day old chicks was not determined. Should bacteria, even though they apparently are not pathogenic for adult chickens, be permitted in poultry vaccines? This is another question worthy of research.

A second problem concerns the contamination of a live virus vaccine with an antigenically similar but more pathogenic strain of virus. The contaminated culture was a B1 strain of virus whose origin is unknown. Many have observed that B1 strain grows slowly in embryonating eggs, embryos which receive 10,000,000 to 100,000,000 50 per cent lethal doses of the virus die 80 hours after inoculation. This incubation period is 30 to 40 hours longer than that of most strains of Newcastle disease virus. Of course, when 10 or 100, 50 per cent lethal doses are introduced death may not occur until the 120 to 140th hour after inoculation.

When B1 strain is introduced into day old chicks, the usual response is a mild respiratory disease without mortality. Many believe this to be the primary character of the strain and do not know that if day old chicks were inoculated intracerebrally with the strain there should be no signs of nervous disturbance and no mortality. The B1 strain, if heated to 56 C for 10 minutes, loses its hemagglutinative activity. These characters of pathogenicity and of virus activity have been observed in the original B1 strain of Newcastle disease virus. There are a number of strains of Newcastle disease virus which, if instilled nasally will produce only a mild respiratory disease but will kill the chicken if given intracerebrally. The variant B1 strain in our collection behaved as the original B1 strain when introduced into day old chicks by nasal instillation. It could readily pass for a B1 strain on a production line and meet the usual safety test requirements. However, the variant strain killed embryos more quickly than did the original strain. Large amounts of the virus killed a few embryos as early as 48 hours after inoculation. In the higher dilutions, death occurred slowly. Embryos receiving 10 to 100 LD₉₀ doses of the virus died 120 to 140 hours after inoculation. This incubation is similar to that of the original B1 strain. The straight line correlation between Log of the dosage and
death time, which we have found to be characteristic of most strains of Newcastle disease virus suggested that the curved line given by the variant B1 strain indicated that it was a mixture of two or more strains of virus.

An attempt was made to resolve the mixture, if such it was. Large numbers of embryos were inoculated with the virus and the embryos which died earliest and those which died latest were harvested separately and materials from them inoculated into another group of embryos. This was repeated in two parallel lines through several passages until a characteristic pattern emerged. A rapidly growing strain and a slow growing strain were selected from the variant B1. The rapidly growing strain when introduced intravenously or intracerebrally into day old chicks produced death. The slow growing strain when introduced intravenously or intracerebrally produced no untoward response in chicks. It appeared that in a strain reputed to be B1 and which had one of the characteristics of a B1 culture, namely that of low pathogenicity on nasal instillation in young chicks, nevertheless, consisted of a mixture of two strains of virus, one of which possessed considerable pathogenicity. The fact that high dilutions of the variant virus seemed to consist almost entirely of the less pathogenic or the slow growing virus suggested that it predominated in the culture, perhaps in a ratio of a 1000:1 or greater.

How long such a mixed culture could be maintained and whether it would lead to trouble if it were used as a commercial vaccine is open to question. But experiments with the influenza viruses have demonstrated that two different strains of influenza may be cultivated together through many generations with the relative ratios of the two components varying in almost every generation (2). Nevertheless, both of the strains persist. This finding of an inapparent mixed culture suggests one explanation for so-called vaccine breaks in the field.

What do these two illustrations indicate? In the research laboratories of our experiment stations and biologics industry, new information is being obtained that questions both old and new products and old and new tests. We should not decry change because it is change. If someone proposes that vaccine be sprayed in the chicken house or that vaccine should be mixed in the drinking water we should not say no because the idea is new. We should ask questions that cut deep into the potential problems of the new method. Is it impracticable? Are there possibilities of carriers arising or a selection of pathogenic mutants. Is it a human health hazard? We should seek reasonable answers and decide whether the benefits outweigh the risks. Reconsideration of methods and materials means better biologics.

We should try to develop a control organization that will be able to establish and maintain a policy of critical evaluation and intelligent revision of vaccine standards. If the federal control agency is to do this effectively, it must have increased facilities and a larger staff of adequately trained scientists.

REFERENCES

Since the etiology of psittacosis was first identified as a specific virus in 1929 and 1930, the natural host spectrum to this disease has rapidly and broadly been expanded with the continued discovery of new hosts. Psittacine birds now represent only a part of a vast and growing reservoir for this disease. Many other avian species including pigeons, ducks, chickens and turkeys have been found naturally infected. In addition, viruses morphologically and antigenically indistinguishable from the psittacosis-lymphogranuloma venereum group have been isolated from several mammalian species.

The susceptibility of man to the psittacosis viruses of avian origin has long been established and the public health hazard attendant the raising, handling and fondling of infected pigeons, parakeets and other cage birds has been convincingly demonstrated. Dramatically coming into view more recently is the potential public health, veterinary and economic significance of the disease in certain of our domestic fowl. In Texas at least ten outbreaks of psittacosis in which turkeys were suspected or proved to be the source of infection have occurred among poultry plant workers in the past several years.

The first suspicion that turkeys were serving as a source of human infection was recorded by Irons et al. (1) following the investigation of an outbreak of psittacosis in a poultry dressing plant at Giddings, Texas in November 1948. There were twenty-two cases and three deaths among seventy-eight employees in this outbreak. Although no attempt was made to recover virus from turkeys at this time, epidemiological evidence quite clearly indicated that turkeys were the source of infection. A second outbreak occurred at this same establishment in late December 1951 and early January of 1952, and a third outbreak during April and May of 1952. These two outbreaks accounted for sixty-three more cases and four more deaths. A second plant at El Campo, Texas was struck late in 1952 and early 1953. Investigation of this outbreak was impeded because of a concurrent influenza epidemic—nevertheless eight cases of psittacosis were laboratory confirmed. The explosive nature of these outbreaks suggested that exposure occurred on one particular day and that very likely a single flock was responsible in each instance. Using the incubation period as an index for determining the exposure date, a flock with a history of an undiagnosed illness was singled out as a probable source of infection in the second Giddings outbreak. From two hens selected for autopsy out of the balance of the flock remaining on the farm, a virus indistinguishable from the psittacosis L.G.V. group was recovered by Boney et al. (2). This marked the first recorded isolation of psittacosis virus from naturally infected turkeys and conclusively confirmed the suspicion that turkeys were harboring the agent. The properties of this isolate, now

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referred to as the "Texas Turkey Strain" were fully studied and recorded by Meyer and Eddie, (3).

During April, May and June of 1954 a series of outbreaks occurred in six more Texas poultry dressing plants. Approximately two hundred cases and one death resulted from these outbreaks, Irons et al. (4).

**EPIDEMIOLOGICAL AND CLINICAL FINDINGS**

The marketing and dressing of turkeys is a seasonal operation in Texas. Turkeys are dressed from September through December for Thanksgiving and Christmas and then again in late spring at the end of the egg-laying season. Most of the involved plants have been operating and dressing turkeys for a good many years. The outbreaks of illnesses they have been experiencing in the past few years seem to be an entirely new problem. There is nothing unusual about the construction nor the manner in which these plants operate. Turkeys are trucked in directly from the farms and are processed shortly after arrival. Occasionally they are held overnight. All the plants follow a complete or "full dress" procedure. The first outbreak at Giddings occurred, however, while turning out a "New York" dressed product. Along the assembly lines in the picking and pinning rooms a detectable fine moist aerosol is created by the action of the mechanical pickers and buffers. The highest employee attack rate has been among the eviscerators and those pickers and pinners continually exposed to these moist aerosols. There is little question that these outbreaks represent principally an airborne type of infection. The additional possibility exists that virus may gain entrance through cuts and abrasions, while handling infected tissues.

Most of the outbreaks were of an explosive nature. In a few plants where several infected flocks were processed at intervals over a few weeks, the appearance of cases extended over a longer period of time. The severity of the individual cases varied from mild influenza-like attacks to a more serious illness requiring hospitalization. The onset was generally characterized by chilly sensations, fever, malaise, myalgia, headaches and sometimes nausea and vomiting. After the illness had progressed a few days the patients usually felt much worse. Although relatively few complained of cough some complained of soreness in the chest. Physical signs and symptoms referable to the respiratory tract were not too pronounced. On roentgenologic examination an interstitial pneumonitis was detected in many patients. Several patients in each outbreak had one or more relapses. A number of broad spectrum antibiotics were used with apparent success. Diagnosis was established on the basis of epidemiological, clinical and laboratory findings.

**EPIZOOTIOLOGY**

During the course of the spring outbreaks in 1954 several flocks were singled out as the source of infection. Indeed, in a few flocks the infection was recognized and diagnosed before the outbreaks they caused occurred. In two plants the outbreaks were predicted to the day of the first case on the basis of such findings. Unfortunately, laboratory confirmation of the disease in these flocks was not obtained until a couple of days after they were dressed. To date virus has been recovered from turkeys on at least twelve different farms representing three distinct geographic foci.
within the state. It appears quite likely, in Texas, that the disease in turkeys is widely and latently seeded. A limited serology survey using the indirect complement fixation test was conducted by Irons, et al. (4) and Meyer and Eddie, (3) on widely scattered Texas flocks. Latent infection levels ranging from six to forty per cent were suggested by this test. All of the flocks tested with a single exception showed some serological evidence of infection, yet clinical manifestations were lacking. That true acute and subacute epizootics can occur was repeatedly demonstrated in several flocks this spring (1954). These epizootics were not dramatized by an explosive onset but instead after an insidious beginning they proceeded along a rather slow progressive course extending over a few weeks to a month or more. Such non-specific signs and symptoms as droopiness, weakness, immobility, anorexia, fever, yellowish-green, soft to fluid feces and occasional respiratory difficulties characterized the clinical manifestations in individual birds. Egg production and hatchability declined rapidly during the epizootic. Toms and hens appeared to be affected equally. While the clinical course in many birds was prolonged, in others it was short. Frequently no unusual symptoms preceded death. The mortality rate of clinically evident cases has not been established but recovery was common. In two flocks of about fourteen hundred birds, the death loss in each was around one hundred over a three to four week course.

POST-MORTEM FINDINGS

On autopsy the findings are variable, being neither pathognomonic nor consistent. Virus has been recovered from individual birds showing little if any gross pathology. The most prominent and consistent lesions are those of a subacute or chronic inflammation of the serous surfaces. The air sac membranes are often cloudy or thickened, while the mesentery and visceral surfaces are frequently injected and covered with fibrinous exudates varying from whitish-grey flakey deposits to an extensive fibrinous membrane.

At times the liver is slightly enlarged and discolored by greyish and greenish bands. Small foci of necrosis and areas of mottling are common, and more frequently a whitish plastic-like fibrinous film will be adherent to the surface. This may cover only small areas or may extend over the greater surface of one or both lobes. The spleen is usually mottled and dark purple in color. Splenomegaly one to three times the normal size is frequent but not consistent. Grossly, the kidneys have shown nothing unusual. Frequently the abdominal cavity of the breeding hens will contain a rather large quantity of a thick yellow brown fluid. This has not been observed in toms and is presumably yolk material occupying the cavity following rupture. Well developed follicles may be seen, however, even in the presence of other extensive pathology.

Pericarditis is a common finding but may vary from a few scattered petechia to a severe fibrinous inflammation and chronic thickening. The pericardial sac may contain accumulations of fluids, fibrinous exudates—and is occasionally adherent to the epicardium. Additional pathology may be found in the form of epicardial petechia, subepicardial edema and myocarditis. A diffuse type of pneumonia with peripneumonic accumulations of fluids has been seen on occasion. In many of the more extreme cases a cachexia was noticed.
CONTROL METHODS

Thorough understanding of the natural epizootiology is needed before a solution to the control of this disease in turkeys can evolve. The mechanism by which infection is introduced into a given flock has not been demonstrated. If the mode of transmission responsible for carrying the infection into successive generations is centered around the hatchery, the potential disseminating capacity of such a mechanism is readily apparent. The necessity of devising a method of control for this problem cannot be questioned. The public health implications alone, without consideration of economic factors, poses a serious enough threat to allay any passiveness regarding this need. A number of plants in Texas have adopted the policy of requiring their employees to wear surgical masks when working in the picking and eviscerating units, and rubber gloves while handling the viscera. The limitation of these precautions in the face of a filterable agent is fully appreciated and they of necessity stand to be replaced whenever a more applicable and effective method of protection is advanced.

As yet the disease in turkeys, has been reported only in Texas. This should not however, serve as excuse for complacency in other areas. The possibility that it could exist and that it may appear elsewhere should not be overlooked by public health and livestock disease control officials. The scope of the problem in Texas has decidedly served notice on the need for the development of an effective means of control.

REFERENCES

One of the limiting factors governing the economics of the poultry industry is the problem of maintaining good livability. As the margin of profit is reduced, good livability becomes of increasing importance. However, the rapid increase in the poultry population tends to increase the disease hazard on poultry farms.

There is an ever increasing need for improved veterinary service in order to cope with the present poultry health problems. Veterinarians are becoming more cognizant of the importance of developing a poultry practice. More information should be made readily available to the veterinary profession by way of increasing their training in college, as well as providing short courses, and regional conferences in order to provide interested veterinarians with the latest developments. It is hoped that this report will partially fulfill this need.

**RESPIRATORY DISEASES**

Infectious laryngotracheitis often occurs in sectional outbreaks. If promptly diagnosed, it is subject to control by emergency vaccination of affected and neighboring flocks. The danger lies in survivors which are potential carriers and may give rise to new outbreaks. As long as survivors remain on the premises, preventive vaccination of all growing birds at six weeks of age is indispensable.

Newcastle disease remains to be an important economic problem of chickens and occasionally of turkeys. In the latter species a nervous, nonrespiratory form may occur which must be diagnosed on the basis of neuropathological changes and virus isolation. Mass vaccination methods by spray, dust, and through the drinking water (1) have been suggested and are promising. The latter method has the advantage of being economical from the standpoint of price and labor involved, making the poultryman independent from hatchery vaccination and vaccination crews, permitting booster doses when needed, and reducing human health hazard. The best time for oral vaccination and booster doses, virulence of vaccine strains, need for stabilizers in the water, and so forth, await further practical experience.

*Newcastle disease*: Hanson (2) demonstrated mixed infections with Newcastle disease (ND) virus and infectious bronchitis virus in susceptible chicks. Simultaneous propagation of these viruses in embryonated chicken eggs was accomplished with lethality of Newcastle disease virus masking the action of infectious bronchitis virus. Demonstration of each virus was accomplished by neutralization with specific immune serum. Chickens surviving dual infections developed antibodies against both viruses. Infectious bronchitis (IB) virus was capable of inter-
ferring with the development of Newcastle disease symptoms in chicks inoculated intranasally with both viruses.

Broadfoot et al. (5) reported that naturally occurring infectious bronchitis during the first week after hatching may interfere with, or have adverse effects on, later egg production in some birds as reflected by eggs of poor quality or pathological alterations of the ovary and oviduct. Infectious bronchitis in laying flocks can result in a statistically significant decrease in egg production and hatchability, and an increase in percentage of unsettable eggs. The disease can cause a flock to produce fewer eggs in toto, a larger percentage of eggs rejected for incubation, and a smaller hatch from eggs set. These effects can have an important economic bearing upon hatchery profits.

Growth curves determined by Hitchner and White (6) with the Connaught Laboratories vaccine strain of the virus by making pooled harvests of allantoic fluid from groups of embryos inoculated with $10^{-1}$, $10^{-3}$, and $10^{-5}$ dilutions of the virus showed that embryos inoculated with the highest concentration of virus attained the log phase first. Maximum virus concentration (EID$_{50}$ titers exceeded $10^{8}$ per ml.) was reached 24 to 30 hours postinoculation with all three concentrations of inoculum. With the Beaudette embryo lethal strain using a $10^{-3}$ dilution of virus for inoculum, the log phase of growth was attained four hours postinoculation and a maximum EID$_{50}$ titer of $10^{-8.5}$ per ml. was reached in 18 hours. Luginbuhl and Jungherr (1) investigated the possibility of the administration of Newcastle disease and infectious bronchitis vaccines through the drinking water. Vaccine viruses, as infected allantoic fluid, were added to the drinking water at the rate of 0.5 ml. per gallon, giving a final concentration as embryo infective doses of $10^{-6}$ for Newcastle disease virus and $10^{-3}$ for infectious bronchitis virus. The viruses were found viable for 28 and 11 hours, respectively. Susceptible chicks exhibited takes and were positive to the hemagglutination-inhibition test for Newcastle disease and to the serum neutralization test for infectious bronchitis. Combined Newcastle disease and infectious bronchitis immunization of parentally immune flocks showed mild uniform takes. Vaccine administration via drinking water seems to obviate some objections to spray technique and to open the possibility of effective, labor-saving, initial and booster immunization.

Markham et al. (7) have shown that finely divided dry infective chick embryo fluid residues dispersed by means of simple dust pumps and aerosol dispensers over the heads of birds varying in age from one day to several weeks produced responses comparable to those obtained by conventional methods of vaccination. Serum neutralization, hemagglutination-inhibition and challenge tests demonstrate the method to be safe, practical, and effective in immunizing against Newcastle disease and infectious bronchitis.

Markham et al. (8) reported that the feeding of high levels of aureomycin, ranging from 10 grams per ton of feed to 300 grams did not inhibit the development of a normal immune response to vaccination of chicks five to eight days of age with a combination Newcastle disease and infectious bronchitis vaccine as demonstrated by serum neutralization, hemagglutination-inhibition and challenge tests.

Page (9) has found that infectious bronchitis immune serum could be stored for eight weeks at 4 C. and seven days at 22–25 C. without significant change in neutra-
lizing capacity. A 10-fold decrease in neutralizing capacity occurred in 56 hours at 37°C.

A real evaluation of vaccination programs is difficult, as can be seen from the opinions submitted. In summary, it would appear that ND vaccination is almost universal and that the majority of chicks in broiler areas are vaccinated under 14 days of age. The intranasal and intraocular methods are most widely used, although spray and drinking water procedures are being more widely used. Revaccination at four weeks in heavily exposed flocks is widely recommended and here the spray and drinking water procedures are gaining in popularity. Vaccination against IB is controversial. Procedures in broiler areas vary from one to 10 day old vaccination with a mild strain, to three to four weeks old with no mention of strain, to no vaccination whatsoever for IB.

**AVIAN LEUKOSIS COMPLEX**

"The avian leukosis complex" is the cause of a greater loss to poultrymen than any other disease. Recent studies indicate that the neural, visceral and ocular lymphomatosis, osteopetrosis, and the blood forms of the disease are caused by separate or closely related agents. This should help explain some of the complexities of this disease group which have plagued workers in the past.

Gentry (12) placed the transmission of visceral lymphomatosis into four main types, 1) direct bird to bird contact; 2) indirect contact such as the caretaker; 3) transmission from dam to off-spring, via the egg; 4) artificial exposure by the injection of infectious material.

There are many undetermined factors, but direct and egg transmission are considered the most important types of transmission for visceral lymphomatosis. Direct bird to bird contact is apparently limited to the first few months of the chick’s life. Contact of chicks with infected adults is not as important as chicks in contact with infected chicks. This is of particular significance when one considers the possibility of incubator transmission. Burmester (14) provided unquestionable evidence that the virus of visceral lymphomatosis is present in embryonating chicken eggs and is presumably transmitted from parent to offspring in this manner. The use of solid wall cubicles, open at the top and with wire floors, seems to prevent the spread of lymphomatosis.

Burmester and Gentry (13) exposed chicks by various routes of inoculation. The tracheal and intraperitoneal routes of inoculation were the most effective.

The various routes tested gave the following per cent tumor incidence: tracheal, 83.1; intraperitoneal, 82.6; nasal, 73.0; cloacal, 57.6; conjunctival, 47.2; oral, 45.2; aerogenic, 39.2; and esophageal, 7.7. Non-inoculated controls developed an incidence of 1.3 per cent.

Any one of the mucous membranes constitute a susceptible route of inoculation. Burmester and Gentry (14) demonstrated the presence of the virus of visceral lymphomatosis in oral washings and not in fecal extract of naturally occurring cases of visceral lymphomatosis. Clinically normal birds in an infected population did not yield the virus in significant amounts. From birds that were artificially exposed at one day of age, the virus was demonstrated in fecal extracts and oral
washings of clinical cases of visceral lymphomatosis as well as clinically normal birds.

Beard and co-workers at Duke University have made considerable progress on basic studies of erythromyeloblastic leukemia. Cole (15) used an oncolytic virus in an attempt to control leukemia without success.

The Regional Poultry Disease Laboratory, East Lansing, Michigan, reported on a test for avian lymphomatosis based on the reaction of adenosine triphosphate with its chemical namesake adenosine triphosphate. This test is based on earlier research at Duke University.

ENLARGED JOINT CONDITION OF POULTRY

An apparently new disease called "enlarged joint condition of poultry" has been reported by Olson (17, 18) and Wills (19). Due to the pathology involved, Olson has suggested the term avian infectious anemia—Synovitis, rather than enlarged joint condition. The disease is characterized by general weakness, anemia, ruffled feathers, emaciation, enlargements of one or more joints, breast blisters, and pale combs in the early stages of the disease. In later stages of the disease, the combs shrivel and may become somewhat cyanotic. Affected birds have low red blood cell and high white blood cell counts.

The swellings about the joints contained a viscous creamy exudate which became "cheese-like" in the later stages of the disease. Many times there was viscous exudate about the joints without any apparent swelling. This condition resembled synovitis rather than an arthritis. The liver may be enlarged and show greenish discoloration. Splenomegaly was present in about 50 per cent of the cases.

The infectious agent could not be cultured on ordinary cultural media, but could be grown in the yolk sac of five to six day embryonated chicken eggs. Embryo mortality in early passages was very erratic, but after 19 passages embryo mortality was consistent. One-quarter ml. of inoculum was used. The causative agent is not known, but is believed to be either a large particle virus or small bacterium.

Chicks were artificially infected by inoculation of fluid taken from around affected joints, or by egg-grown material. Pad, joint, and intravenous routes of inoculation were the most effective. The incubation period of inoculated birds was short, four to six days, but contact controls did not become infected until after an incubation period of 30 to 40 days. Three to four week old turkeys were susceptible to the disease when inoculated intravenously and into the foot pad with synovial fluid taken from infected chickens (18).

The disease has caused considerable losses in broilers but has also appeared in laying hens. The disease has been reported from Texas, Delmarva Area, Arkansas, West Virginia, Connecticut, and Pennsylvania. The disease is thought to be widespread in the United States, and a committee should be appointed to make a study of the extent of this disease.

CHRONIC RESPIRATORY DISEASE

Van Roekel et al. (20) have established without a doubt that the chronic respiratory disease (CRD) agent can be detected in embryonated eggs and young chicks
originating from CRD infected hens. It has not been determined whether the agent eliminated in the egg is capable of initiating a CRD outbreak in chicks originating from these eggs. Field evidence suggests very strongly that such may be the case.

Jungherr et al. (21) conducted pathogenicity tests with seven pleuropneumonia-like organisms from different sources. That data permitted the following conclusions: (1) avian PPLO strains from different species and geographic regions were definitely pathogenic both after prolonged egg and culture propagation, (2) that there may be a variation of the pathogenicity of avian PPLO due to innate characteristics, (3) histologic examination for takes was approximately 33 per cent more sensitive than gross examination and had the advantage of producing a permanent record, (4) intraocular inoculation on basis of histology, was more sensitive than intratracheal or intrasinusoidal inoculation, (5) the number of takes on the 7th postinoculation day was significantly less than on the 14th to 35th day, (6) the possible influence on the present results of intercurrent bronchitis outbreaks must be checked further.

Lecce et al. (22) reports that pleuropneumonia-like organisms (PPLO) are microorganisms that have characteristics quite distinct from those of the bacteria and the viruses. A few of these more important characteristics are as follows: (1) PPLO have a slow rate of growth and require highly nutritive media. (2) The individual organisms are at the limits of visibility of the light microscope. (3) The colonies grow into the agar and because of their small size, they must be magnified in order to be seen. (4) Little or no turbidity develops in broth cultures. Jacobs et al. (23) made a study of the seriological tests for the detection of CRD in chickens and turkeys. The tests of choice are the hemagglutination, the hemagglutination-inhibition, the tube agglutination, and the whole-blood test. Adler (24) developed a technique for the diagnosis of CRD by means of a slide agglutination test.

Osteen (25) reports that accumulative results of various treatments indicates none to be specific except where other respiratory diseases are complicating factors.

SALMONELLA INFECTIONS

Continuous gains are being made in the control of pullorum disease as evidenced by the report compiled by Baker (51) covering the states in the Northeastern Pullorum Conference. For instance, Maine had a record of 1,504,735 birds tested, with only two reactors found.

Further evidence of the progress made in the eradication of pullorum disease is shown by the action of the National Poultry and Turkey Improvement Plans, whereby, all pullorum tolerance classes were eliminated. Likewise, fowl typhoid is classified along with pullorum disease when rating a flock or hatchery. The poultryman has the option of submitting reactors to a recommended laboratory for culturing. If the laboratory fails to recover the Salmonella pullorum or Salmonella gallinarum organisms a flock may be declared negative. Should other salmonella species be isolated from flocks, the disposition of this flock is handled separately in accordance with the wishes of the official state agency.

S. pullorum contaminated fowl pox vaccine accounted for numerous breaks in
clean flocks. Eight out of 15 breaks in New York State were traced to pullorum contaminated fowl pox vaccine. In Virginia contaminated pox vaccine used in 229 flocks (112,908 birds) resulted in a reaction of 5.9 per cent on the initial test. Pullorum breaks from pox vaccine were also reported in several other states. Connecticut (26) reported on the experimental contamination of fowl pox vaccine and established pullorum infection by the intradermal route when as few as ten organisms per cm² were used.

New diagnostic procedures have been adopted under the National Poultry Improvement Plan. These include the use of Waring Blender technique for grinding tissue for cultures and thus releasing the organisms. New media of both the selective and non-selective types have been adopted.

Fowl typhoid is always a potential threat to the poultry industry. Massachusetts (27) has inaugurated a state control program wherein suspicious flocks can be quarantined and tested and reactors destroyed without compensation. However, the problems of dead bird disposal, of contaminated trucks and crates, and the disposal of slaughterhouse wastes are largely unsolved.

Many species of the genus Salmonella other than S. pullorum and S. gallinarum can act as etiological agents of disease in turkeys. California (28) has initiated the S. typhimurium detection service on a voluntary basis using a specially prepared antigen.

Isolation of paratyphoid organisms from domestic ducks continues to be reported (29). Mortality starts soon after hatching and extends over a period of two to three weeks and ranges from one per cent to sixty per cent. Sulfonamide therapy in the drinking water and rigid culling are effective in reducing mortality.

**Erysipelas**

Erysipelas continues to be a disease of increasing importance as field reports indicate a greater tendency for the disease to reoccur year after year on turkey farms. At least two reports have appeared in the literature of the disease affecting chickens. This is unusual for this country but it has been more of a problem in Europe.

Antibiotics (particularly penicillin products) are used to treat individually infected birds with fair success if treatment is started in time. A combination of two or more antibiotics such as penicillin and dihydrostreptomycin apparently are being used to good advantage in some cases. There is a growing interest in the use of bacterins as a preventive against this disease. Controlled experiments indicate that some benefit may result from bacterins alone or in combination with the proper antibiotics. Further research is needed to determine the most effective means of control.

**Coccidiosis**

Tyzzer (30) has stated that there are as many kinds of coccidiosis as there are species of coccidia. Hence, it is apparent that the foundation for the successful study and control of this disease (regardless of the host) creates a need for a thorough understanding of the characteristics of the various host-species, which act singularly or in combination to produce this disease.
All available techniques should be utilized by investigators when the identification of coccidial species are attempted. Detailed methods are available for the identification of most common species of plants and animals. There is a lack of uniformity as to the criteria employed for the isolation and identification of coccidia. A sufficient number of criteria should be fulfilled in order that a valid species may be identified.

One of the more commonly used criteria for the identification of coccidia is morphological characterization. Generally speaking, these characteristics are not adequate for the positive identification of coccidia. For example, *E. dispersa* was at one time recognized as the only species of coccidia affecting gallinaceous birds that possessed no refractile body (polar granule). Work by Moore and Brown (39) and Moore, Brown, and Carter (40) through the use of several critical tests has resulted in the isolation and identification of two other species of coccidia affecting turkeys that have no refractile granule, namely, *E. innocua* and *E. subrotunda*.

Tyzzer (31) has stated that one expects work in this field to be as critical as in any other. Unfortunately, there is still need for much improvement with regard to the use of modern criteria for the isolation and identification of species of coccidia as reported by Moore, 1953 (36).

The first requisite for the accurate isolation and identification of coccidia consists of a single-cell isolation. Reproducing oocysts from this single-cell, by feeding it to coccidium-free hosts and maintaining the pure culture throughout the remainder of the study is necessary. From the progeny of the single oocyst, one should study the morphological characteristics, prepatent period, patent period, sporulation time of oocysts, host specificity, symptoms, area of intestine affected, histopathological changes of infected tissue, and the immunological reaction. Of these many criteria, perhaps the antigenic specificity is the most important single criterion.

It is recognized that some species of coccidia are harmless as measured by the effect on feed consumption and weight gain, while others are highly pathogenic. Therefore, it is evident that diagnosticians should be familiar with the characteristics of the various species of coccidia affecting a given host, in order to properly evaluate their significance when finding large numbers of oocysts in a given host. In other words, it is not sufficient to demonstrate the presence of coccidial oocysts. It is more important that the symptoms and pathologic changes which they may produce be considered.

Research work conducted at Cornell University and the Ohio Agricultural Experiment Station indicates that some of the commonly used coccidiostats are not equally effective against all species of turkey coccidia. Among the drugs investigated, sulfadimethoxin has given uniformly good results.

**HISTOMONIASIS**

Histomoniasis (blackhead) continues to be one of the more devastating diseases of turkeys. Studies are in progress at different experiment stations to evaluate the efficacy of existing histomonastats and to discover new remedies. Some of the existing histomonastatic agents retard weight gains when fed continuously. Likewise, hatchability may be reduced.
HEMORRHAGIC SYNDROME OF CHICKENS

During the past year little new information about hemorrhagic disease has been reported. The disease is still a serious problem in young flocks, especially in some broiler areas. Gray et al. (47) reported recently the pathological findings in 102 birds from eight flocks which were characterized by hemorrhages, pale blood, and fatty bone marrow. Liver necrosis and intestinal ulcers were frequently associated secondarily with the condition during the late stage of the disease.

Blood studies revealed prolonged clotting time, anemia, and fluctuations in number of thrombocytes and granulocytic components of the peripheral circulation. Aplastic anemia was seen frequently in severely affected birds. It is emphasized that hemorrhagic syndrome probably is most frequently confused with intestinal diseases.

Bornstein and Samberg (48) observed field cases of Vitamin K deficiency in Israel which revealed a pathological picture that simulated the hemorrhagic syndrome in this country. These cases responded to vitamin K therapy. No explanation was given for the vitamin K deficiency although it is believed that antibiotics and coccidiostats may be contributory causes. This latter view is not shared by all workers in this country. It is known that hemorrhagic disease may occur in chicks being fed a vitamin K fortified ration. For the present, it may be concluded that the etiology of the disease remains vague and that specific diagnostic criteria have not been established.

A hemorrhagic syndrome has been observed in turkeys by Moore of the Ohio Agricultural Experiment Station. The gross and microscopic lesions closely resemble the hemorrhagic syndrome of chickens. Lesions on the feet and the characteristic small red and white pinpoint foci as seen on the serous surface of the intestines of chickens have not been observed in turkeys. A severe hemorrhagic enteritis may be more characteristic of the hemorrhagic condition of turkeys than in chickens, although bloody droppings may be discharged by both.

ORNITHOSIS

In the 1953 report of this committee, attention was called to the potential significance and importance of ornithosis as it has been observed to occur in turkeys and transmitted from turkeys to poultry processing plant workers. At the time of this report, epidemics had been observed only in the workers of one or two poultry dressing establishments and the virus had only been recovered from one flock of turkeys during 1952. In 1953, no infections were observed either in poultry plant workers or turkeys.

In April, 1954, shortly after Boney, Wills, and Pate (49) recognized a suspicious case among turkeys which was later confirmed by Irons (50), the first outbreak among dressing plant workers was recognized. Since then (April-July, 1954), one hundred and forty-nine human cases in five different establishments have been encountered. Fortunately, there have been no human fatalities during the 1954 season. During this same period, ornithosis virus was isolated from fifteen turkey flocks. Of interest was the occurrence of the infection among two veterinarians and a laborer in the diagnostic laboratory further indicating the transmissibility of the turkey infection to man.
The symptoms as observed in the turkey flocks were not particularly striking, except for a few individual sick birds and some mortality. Egg production, fertility, and hatchability may have been affected in individual instances; in others, egg production, fertility and hatchability was very good.

With this year's experience, the importance of this disease has been established as one of importance to the field of veterinary medicine and public health. It is believed that this disease occurs wherever turkeys are reared and is not limited to Texas. It is admitted that with our present knowledge regarding symptoms and lesions as they occur in the turkey could very well be masked by the internal form of infectious sinusitis or "air sac disease", and perhaps in chickens by the better recognized respiratory diseases.

OUTSTANDING POULTRY DISEASE PROBLEMS IN CANADA

In assessing the major poultry disease problems in Canada, the intricate part played by management cannot be excluded. If management were to be recognized as a classical disease embracing those faults and failures which contribute to a disease entity, it would probably lead the list. The corrective treatment for "management disease" is a positive extension program lead by veterinarians whether in practice or in public disease control positions and based on practical preventive measures of sanitation. In the misapplication of recent advances in science such as the indiscriminate use of antibiotics and sulpha drugs, management has been neglected and in many cases forgotten.

The four major diseases of poultry which continue to lead the list of pathologist's reports in Canada are coccidiosis, tuberculosis, parasitism and avian leukosis complex, particularly the visceral and neural forms.

Fowl typhoid appears to be endemic in certain areas of the country where poultry sanitation and management are inefficient. New species of salmonella are continually being found on premises where sanitation is poor. The most commonly found salmonellae which produce a considerable mortality are \( S. \) oranienburg, \( S. \) bariety, and \( S. \) typhimurium. Research efforts towards developing test antigens to identify infected flocks are progressing.

Respiratory diseases as a group are causing some concern, particularly chronic respiratory disease. Of major concern to disease control officials and the poultry industry alike is lack of knowledge as to immunity, if any, which is conferred on a flock following infection. The carrier bird problem is also an unknown factor. The very mild form of newcastle disease present in Canada is a problem only when owners have failed to properly immunize their birds. Infectious bronchitis of an extremely mild nature is known to be fairly widespread. Its damage on egg quality and egg production in mature flocks represents an economic loss which can only be corrected by educating poultry owners in methods of prevention.

A reduction in the incidence of pullorum disease through the National Pullorum Control Program continues.

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The United States Livestock Sanitary Association needs no introduction to the term "veterinary public health". It might be of interest, however, to consider the responsibilities of such an activity on a global scale, rather than on a national scale. Since veterinary public health is concerned with any linkage between human and animal health problems, it is not difficult to understand why the World Health Organization has taken such an active interest in this field. In fact, soon after its establishment in 1948, the member countries of WHO incorporated activities on brucellosis and rabies as part of the Organization's regular program. Succeeding World Health Assemblies, the governing body of WHO, extended veterinary public health activities to include other major zoonoses, such as bovine tuberculosis, Q fever, leptospirosis, hydatidosis, and meat and milk hygiene, in order to meet the needs of member countries in these fields.

In carrying out its activities, WHO works in close collaboration with the Food and Agriculture Organization (FAO) of the United Nations, and with other international organizations, such as the International Office of Epizootics and the Pan American Sanitary Bureau (WHO Regional Office for the Americas). In addition, WHO keeps in close contact with the permanent organizations which hold periodic congresses, such as the International Veterinary Congress and the International Microbiological Congress.

WHO fulfils its veterinary public health obligations in several ways, i.e., by (a) the provision of specialists to advise government agencies; (b) the organization of regional meetings or conferences to consider and act upon questions of common concern to the countries involved; (c) meetings of committees of recognized experts in a specific field to summarize the latest advances in that field, and to recommend courses of action to guide WHO technical policy; (d) co-ordination and promotion of research activity; (e) organization of technical training courses for field and laboratory workers; (f) publication of documents on technical subjects; and (g) granting fellowships to countries to enable recipients to study abroad.

Some recent developments in WHO veterinary public health activities and problems will be considered briefly.

RABIES

Two meetings of the WHO Expert Committee on Rabies have been held, in 1950 and 1953. In the reports of these meetings will be found recommendations with respect to prophylaxis of this disease in man and animals, field control, and research problems requiring investigation (1, 2). These reports have been widely used by member countries of WHO and have served as the basis for handling the rabies problem in many countries. Recommendations for research made by the Expert Committee have already yielded very fruitful results, particularly with
respect to the use of hyperimmune serum in rabies prophylaxis, the development and field trials of chicken embryo vaccines, and the local treatment of bite wounds.

Two recent publications of WHO are especially worthy of note. The first is a monograph on Laboratory Techniques in Rabies (3), which is proving very useful to laboratory workers on this disease throughout the world; the monograph contains contributions by world authorities on diagnosis, vaccine and serum production, and potency testing. The second publication is a special issue of the WHO Bulletin devoted solely to recent advances in the field of rabies (4).

A rabies meeting was held in India in 1952 to meet the needs of countries in three of the WHO Regions—Eastern Mediterranean, South-East Asian and Western Pacific. This meeting involved lectures, discussions, demonstrations and laboratory training for 55 medical and veterinary workers from 23 countries. WHO rabies consultants acted as discussion leaders and supervised laboratory sessions. A similar meeting is planned for African countries for the summer of 1955.

Q FEVER

WHO has sponsored a survey for Q fever in 28 countries to improve knowledge on the world prevalence of this disease. The results of this survey will be published within a few months and show that the disease is present in many countries where it was formerly unknown. WHO has also been interested in the diagnostic problems involved in this disease, and recently has established an international standard anti-Q fever serum for use in veterinary and medical diagnosis.

BOVINE TUBERCULOSIS

This problem has been considered extensively in publications of WHO/FAO sponsored seminars and Expert Groups (5, 6). International standards for mammalian and avian PPD tuberculin have been established and research is under way to determine the importance of extra-human sources of infection in highly infected human population groups, and also in connection with apparent non-specific reactions to the tuberculin test in human beings.

BRUCELLOSIS

Two Joint FAO/WHO Expert Committee meetings were held, in 1950 and 1952, and a third one is scheduled for 1955. The reports of the first two meetings contain recommendations on brucellosis problems in man and animals, including human chemo-therapy, diagnostic and other laboratory procedures, and field control (7, 8). One of the important results of these recommendations has been the establishment of more uniform procedures and practices throughout the world so that results reported are more easily compared and evaluated. To assist in this work, WHO and FAO have established 14 brucellosis centers in various countries of the world. These centers are used to prepare and test antigens, vaccines, and other biological products, for research on special problems, and as teaching and information centers.

Two brucellosis teaching seminars for medical and veterinary workers, and directed by WHO consultants, have been held in Latin American countries—in Chile in 1952, and in Mexico City in 1954. The meetings were designed to introduce
standardized laboratory techniques and to discuss problems of specific interest to the Latin American countries.

The major world problem in brucellosis today is that of prevention and control of \textit{Br. melitensis} infection in man and animals. Since the classic work of the British Malta Fever Commission, very few advances in knowledge have been made with respect to brucellosis in sheep and goats, the principal reservoirs of \textit{Br. melitensis} infection for man. In order to improve our basic knowledge of \textit{Br. melitensis} infection in sheep and goats, FAO, with the technical collaboration of WHO, organized in 1953 a series of experiments to study the pathogenesis of this disease and to explore the possibilities of developing an effective vaccine for these animals. This work is being carried out in the FAO/WHO Brucellosis Centre at the Pasteur Institute, Tunis, and is being generously supported by the Government of Tunis. The results of the first year's work have given new and important information on the epidemiology of the disease in sheep and goats which will undoubtedly change certain basic control procedures used until now for these animals. Vaccine trials were begun towards the end of the current year and some preliminary results are expected by the end of 1955. These studies are projected for several years.

\textbf{LEPTOSPIROSIS}

In order to obtain more accurate information on the prevalence of this disease, and particularly the role of domestic animals as reservoirs, WHO is trying to assist in the development of stable killed antigens suitable for screening purposes in public health and veterinary diagnostic laboratories. The lack of a readily performed diagnostic test has held back knowledge of the prevalence of this disease. In addition, a better definition of leptospira serotypes would be useful, and research work along these lines is being encouraged by WHO. Limited field surveys are also being undertaken.

\textbf{HYDATIDOSIS}

WHO and the PASB (WHO Regional Office for the Americas) are assisting in field control programs against hydatidosis in many countries. One of the problems encountered in the field has been certain difficulties attached to the use of arecolin hydrobromide as an anthelmintic in dogs. WHO is assisting in investigations into the use and efficacy of other anthelmintics, and the effect of various antiseptics on echinococcus eggs.

\textbf{FOOD HYGIENE}

The main emphasis in this field has been with respect to milk and meat hygiene, and WHO has carried out its work in collaboration with FAO. In milk hygiene, two training courses of a month each have been held, one in Rome in 1953 for European and Mediterranean countries, and one in Bombay in 1954 for Asian countries. In addition, FAO and WHO sponsored the preparation of a published monograph covering all aspects of milk pasteurization (9).

In meat hygiene, a WHO/FAO Seminar for European countries was held in Copenhagen in 1954. This meeting covered problems connected with abattoir hygiene, meat inspection, laboratory tests, the control of food handlers in meat
markets, and the education and training of meat inspectors. The publication of the proceedings of this seminar is expected in 1955. At the end of 1954, a WHO/FAO Expert Committee on Meat Hygiene will meet in Geneva to draw up a report on the subject for use by member countries.

STRENGTHENING NATIONAL VETERINARY PUBLIC HEALTH ORGANIZATIONS

In all the activities described previously technical consultants have been sent to particular countries throughout the world to advise on specific problems and, at

Organization of Veterinary Public Health of National Public Health Service

Public Health Service
↓
Section or Division
Veterinary Public Health

Regional Health Unit
(Province or Large Municipality)
Veterinary Public Health Unit

Rural Health Unit

National Livestock and Veterinary Services

Regional Livestock and Veterinary Services

Local Veterinarian or Veterinary Assistant

Zoonoses: Reporting, statistical analysis, surveys and control measures

Food Sanitation: Regulatory supervision of meat and milk and inspection services

Consultation and Research: On animal disease problems of human interest, epidemiology of infectious diseases, nutrition, public health, medical and veterinary education, etc.

Zoonoses: Reporting and control; epidemiologic surveys

Food Sanitation: Supervision of operational services in meat and milk control (slaughterhouses and dairies)

Consultation: Regional Public Health planning and education of the public

Zoonoses: Reporting and control

Food Sanitation: Supervision of local slaughterhouses, dairies and food markets and preservation establishments

Consultation: Public Health planning and education of public and livestock owners
the same time, to strengthen the organization of veterinary public health units in government health services.

The problem of zoonoses control and veterinary public health organization in rural areas was considered to be of such importance that it was included in the technical discussions held by country delegates during the 7th World Health Assembly in May 1954. The Assembly discussions were very fruitful in pointing the way for many countries to undertake zoonoses control, even those that had little financial and economic resources, and to extend research work in countries where work had already been started. A résumé of these discussions has been published (10), and it is hoped that the complete documents relative thereto will be printed shortly. Attached is a chart showing the inter-relationships of health and agriculture departments through services headed by veterinarians, as discussed at the 7th World Health Assembly.

SUMMARY

The work of WHO in veterinary public health is reviewed. It comprises activities in zoonoses, food hygiene and the strengthening of veterinary public health services in national health administrations. For the zoonoses, particular attention is given to co-ordination of research, and field control activities in rabies, brucellosis, bovine tuberculosis, leptospirosis, Q fever and hydatidosis. Activities in meat and milk hygiene also form a major part of the veterinary public health work in WHO.

REFERENCES

REPORT OF THE COMMITTEE ON PUBLIC HEALTH


Your Committee wishes to point out what appears to be the failure on the part of veterinarians and in particular veterinary practitioners to realize the importance of educating and instructing livestock owners on matters of veterinary public health. From observation and from discussion with veterinarians in many different areas and different fields, it appears that too many of them are more impressed by the number of vaccinations accomplished and the number of tuberculin tests applied or calls made or animals treated than by the time spent in properly educating the owner in the importance of some of the diseases encountered to the public health. Your Committee fully realizes the value of time and the need of busy practitioners for conserving it, but we would call to your attention the fact that a veterinarian is not just a mechanic but a vital and professional part of the nation's health and economy and it is essential that he regard himself as such and act accordingly.

We would call the Association's attention again to the need for a nationwide poultry inspection program. This need is growing month by month as is the realization of this need on the part of the public, the industry and the professional groups. The model ordinance dealing with sanitation in poultry processing has been approved. The ordinance dealing with poultry inspection for wholesomeness has not appeared.

LEPTOSPIROSIS

During the past year the Leptospiroses in domestic animals have been the subject of increased attention on the part of many varied groups. These groups include Public Health Workers, Public Health Research Workers, Animal Disease Regulatory Workers and Animal Disease Research Workers.

Your Committee Report for 1953 discussed the Public Health aspects of this infection and dealt with the various types which had been recovered in culture from domestic animals in the United States.

During the past year additional information regarding the Leptospira has been published revealing a still wider distribution. Leptospira cultures have been isolated from the saliva of infected dogs. Bacteriological isolation of a serotype of Leptospira identical to L. ballum has been made from wild field mice and other rodents. Serotype other than L. pomona are being found both serologically and bacteriologically in cattle. Such types include L. grippotyphosa and L. sejro. L. canicola has been demonstrated serologically in horses. A Leptospiral meningitis syndrome has been reported in cattle and L. pomona has been isolated from the anterior chamber in the eyes of calves.
In the light of the ever broadening scope of the findings being reported, your committee feels that a rapid extension of our knowledge covering this infection is a matter of some urgency. We wish to urge increased awareness and interest in this infection on the part of the practicing medical and veterinary groups and increased federal and state activity in field and laboratory investigation. That the animal Leptospiroses in the United States are a source of human infection is supported by factual evidence. The importance, however, of this infection to livestock health has not been determined and it is felt that until steps are taken to discover the exact place and importance of the Leptospiroses with respect to our animal health, we will not be in a position to gather the necessary information that is of direct public health importance. The Committee therefore wishes to urge that a beginning be made in determining the importance of this infection to the animal population of this nation.

ORNITHOSIS (PSITTACOSIS)

For several years prior to 1952, the number of human psittacosis cases reported annually throughout the country averaged less than 25. However, in 1952 this figure suddenly increased to 135 and has remained at a relatively high level since that time. The most disturbing feature of the increasing incidence of the disease in humans has been the failure, in some instances, to identify the usual psittacine birds as sources of exposure. As a result of epidemiological studies carried out in Texas in connection with human outbreaks, it was found that turkeys may serve as reservoirs of a virus similar, if not identical, to the one responsible for psittacosis. From 1948 through the first six months of 1954, approximately 300 cases of human psittacosis have been diagnosed in Texas, the majority of which occurred in poultry processing plant workers with a history of recent contact with turkeys. Presence of the infection in turkeys has been confirmed through virus isolation studies conducted on birds from suspected flocks. Although adequate data are not available at this time to judge the extent of the disease there is reason to believe that it may be rather widespread. It is hoped that proposed serological surveys in Texas, as well as in other turkey raising states, may throw additional light on this question. Even though explosive outbreaks of human infections have been reported so far only from Texas, it is hard to believe that the disease in turkeys is limited to the State.

So far as the consuming public is concerned, there appears to be little if any threat in handling or eating processed birds. In this connection, both the Public Health Service and the Food and Drug Administration have stated that there is no record of instances where psittacosis has been contracted while preparing or cooking turkeys in the home or in restaurants and that no evidence of human infection has been found to suggest any danger for consumers of turkeys.

Our Committee notes that despite the fact that a number of industrial cases of psittacosis indicates the relationship between psittacosis and fowl other than parakeets, there is still a definite hazard with regard to the individual infected psittacine bird which is brought into the home in close proximity to humans. Our Committee, therefore, recommends that closer attention be paid by the United States Public Health Service and other interested agencies to see that infected diseased birds are not shipped interstate.
Rabies

It is becoming increasingly evident that a closer alliance between Public Health Workers, Animal Disease Regulatory Workers, Wildlife Conservationists and the general public must be achieved in order to effectively deal with the ever increasing problem of Rabies. There is a most unfortunate lack of understanding among these various groups about the activities and aims of the other interested groups dealing with this problem.

Public support for a program designed to control what appears to be just a few cases, is difficult to obtain. Yet, delay until a large number of cases have accumulated, means that the program has been started far too late. This is particularly significant where wildlife species are involved. The presence of rabies in foxes, for example, almost invariably means subsequent losses in livestock. Unchecked, severe economic damage can result, as well as the ever present threat of human exposure.

The habits of foxes tend to produce a seasonal pattern of rabies. Unfortunately, the picture thus presented shows a peak in spring months, after the best time for control has passed. Programs that should have started in December or January, after the first appearance of a case in the fall, often do not develop at that time, because of lack of public interest and support. By June, when local interest has become aroused, fox control has become difficult. With few cases turning up in the summer, interest dies down and no program ensues. A better general understanding of the nature of this disease, and of the many factors involved in its appearance and in its suppression, is essential if successful rabies control programs are to be established.

To the average person, rabies is a disease of dogs. Many people do not realize that it can be contracted by any warm-blooded animal. There are three major groups of animals primarily involved: pets (dogs and cats), stray or feral animals (again dogs, and cats), and wildlife species (mainly foxes in the Middle Atlantic States; skunks, raccoons, and other animals elsewhere). Suppression of rabies is predicted upon a 75 per cent or better control of the groups concerned. That means that 75 per cent or more of the owned pets (dogs and cats) in the affected area must be vaccinated. That means that 75 per cent of more of the stray dogs and cats must be caught and eliminated. That also means that where highly concentrated populations of a wildlife species are involved, their numbers must be drastically reduced. Secondly, and highly important, this control must be obtained in as short a period of time as possible, preferably within three months. Lastly, and most important, the control program must include effective measures against all of the above groups concerned. The first two always go hand in hand and cannot be separated. Every effort should be made to prevent spread of the disease into the third group, the wildlife species, where it is most difficult to bring under control. When present it should be eradicated as speedily as possible. The aims of conservation will not be realized by permitting a disease-ridden population of animals to continue indefinitely. A swift, thorough reduction to prevent further spread through contact will leave a nucleus of sound, healthy stock to the betterment of all. This is not a war against the fox, or the skunk, or any other animal, but is aimed at the disease.
THE USE OF AVIANIZED RABIES VACCINE*

HERALD R. COX, Sc.D., AND ROBERT L. BURKHART, D.V.M.

That rabies remains an important disease problem has been shown by the very interesting reports of Doctor Tierkel and Doctor Dean. However, in the past few years advances have been made in demonstrating that the control of the disease is possible. This paper will be concerned with a brief summary of successful field campaigns with particular reference to the part played by attenuated live virus vaccines in the mass immunization of dogs.

Attenuated live virus rabies vaccines produced in developing chicken embryos have been widely used in the veterinary field in various parts of the world, but are still in the investigative stage in human medicine. The Flury strain of vaccine, developed in our laboratory (1), has had by far the widest application; the Kelev strain, developed by Komarov in Israel (2) has also been used on a limited scale.

The history of the Flury strain was reviewed in considerable detail at the meeting of this Association last year (1), so that it is not felt necessary to repeat all the information at the present time. Suffice it to say that the Flury strain of virus, isolated by Leach and Johnson (3) in 1939 from a human case of rabies, and carried by Johnson through 136 serial brain passages in baby chicks, was adapted to the developing chicken embryo by Koprowski and Cox (4). After 40–50 chicken embryo passages, its pathogenicity for laboratory animals became greatly modified, while its immunizing capacity for intramuscularly inoculated dogs was found to be excellent (5). Laboratory studies were confirmed by field trials (6, 7, 8, 9), and the product was licensed for the vaccination of dogs by the Bureau of Animal Industry, United States Department of Agriculture, in April, 1950 (1).

Subsequent studies on the duration of immunity in dogs carried out in conjunction with the Rabies Control Branch, United States Public Health Service Virus Laboratory at Montgomery, Alabama, showed that the Flury living virus vaccine gave superior results compared to vaccines containing inactivated or killed virus. Thus, of dogs challenged 39 months following vaccination, seven of 30 dogs which had received ultraviolet inactivated vaccine died; as did eight of 34 given phenolized vaccine. There were no deaths among 30 dogs vaccinated with Flury vaccine. Thirty-one of 36 unvaccinated control dogs died (1, 10, 11). These results give additional support to our belief that living modified virus vaccines produce a better and longer-lasting protection than do inactivated vaccines. The excellence of the protection was clearly shown by three field demonstrations in the mass vaccination of dogs which will be reviewed.

ISRAEL

In 1950, the Expert Committee on Rabies of the World Health Organization recommended that the World Health Organization sponsor a demonstration program of rabies control in dogs in an area where rabies was enzootic. To carry out

* From American Cyanamid Company, Research Division, Lederle Laboratories, Pearl River, New York.
the demonstration adequately and to secure a clear picture of the efficacy of the vaccine, it was essential to select a highly enzootic area of limited size. In addition, it was necessary that the area have well-organized veterinary and public health services with adequate facilities and a willingness to cooperate in carrying out the campaign along the required technical lines. The State of Israel was selected as a suitable locality. From 1932 to 1950, the year the vaccination program started, the annual number of rabies cases in animals varied between 50 and 333 (12, 13), a high incidence considering the size of the area. Seventy per cent of the rabies cases was estimated to be in dogs.

From October, 1950, to June, 1953, approximately 30,000 dogs were vaccinated with living virus chicken embryo vaccine—28,000 with the 40-50th egg passage level of the Flury strain prepared by our laboratory, and 2,000 with the Kelev strain prepared by the Virus Laboratory of the State Veterinary Service, Haifa, Israel. All dogs 6 months of age and older were required to be registered and vaccinated. The program was carried out by municipal and state veterinarians and their assistants. It is estimated that by early 1952 almost 90 per cent of all dogs 6 months old or over had been inoculated, but by June 1953 this figure dropped to 70 per cent because of unavoidable difficulties encountered with newly arrived population groups.

All veterinarians and health officers were given careful instructions with respect to detention and observation of suspect dogs and the submission of specimens to a central laboratory for diagnosis. Dogs suspected of rabies, or which had bitten people, were placed in quarantine for 10 days. If they were clinically normal at the end of this period, they were returned to their owners provided they had been vaccinated. All unvaccinated dogs were destroyed. Brain specimens of all animals showing clinical signs of rabies were submitted to the Section of Pathology of the Veterinary Institute in Tel Aviv. The number of cases of rabies in all animals decreased from 194 in 1949—the year prior to mass immunization—to 68 in 1950, 10 in 1951, 11 in 1952 and 6 for the first 10 months of 1953. Thus from January, 1951, when the vaccination program began to reach its stride, through October, 1953, only 27 rabies cases in different animal species were reported, as follows:

21 Dogs
3 Cattle
2 Jackals
1 Mule

Nearly all these cases occurred near the frontiers of surrounding countries where rabies is known to be enzootic.

After the inception of mass vaccination of dogs in October, 1950, only two vaccinated dogs contracted rabies. One came down within two weeks after vaccination, and was undoubtedly incubating the disease at the time of vaccination. The second dog was bitten by a rabid stray dog 51 days after vaccination, and developed rabies after an incubation period of 53 days. This second case must be considered a clear-cut failure of the vaccine.

Human cases of rabies in Israel for 1948–1953 were as follows: 9 in 1948, 6 in 1949, 1 in 1950 and none thereafter. The number of human patients completing a series of vaccine treatments was reduced from 2,035 in 1949 to 476 in 1951.
No revaccination of dogs is planned unless the incidence of rabies increases in the vaccinated animals. Since there is constant danger of rabies exposure from adjacent Arab states, it is possible to ascertain to some extent the efficacy of a single injection of vaccine in conferring durable immunity to dogs. It is significant that although supporting measures such as registration of dogs, compulsory reporting, adequate diagnostic facilities, elimination of stray animals and eradication of possible wildlife hosts were all applied during the years preceding the vaccination campaign, it was not until mass vaccination of dogs was introduced into Israel that rabies was brought under control.

Recent information indicates a recrudescence of rabies in Israel during the first half of 1954 (14): 34 cases have been reported—

30 Dogs  
2 Cows  
1 Horse  
1 Human

It is important to note that none of the dogs had been vaccinated. For financial reasons, the control of stray dogs was relaxed in 1953 and the first half of 1954. This explains the increase in rabies cases, and again emphasizes the need to eliminate stray dogs as well as to carry on a vaccination program. Most of the cases occurred in puppies under 6 months of age and in one district only—the suburbs of Haifa. Following recent experimental findings, puppies are now being vaccinated at two to three months of age instead of waiting until they are six months old.

SOUTHERN RHODESIA

Another area in which a mass vaccination program of dogs was undertaken was Southern Rhodesia. This country had been considered free of rabies from 1913 to August, 1950 (15), when a case of rabies was confirmed in the southwest border area. Investigations indicated that the disease probably had been present there since the previous February, 1950. Africans living along the border, although very reticent, reported that stray dogs—undoubtedly rabid—had bitten other dogs and small stock. The domestic dog population is estimated at 250,000. The most important wildlife species susceptible to rabies are jackals (Thos adustus), civet cats (Civetictis civetta) and honey badgers or ratels (Mellivora capensis).

Within six months of the first case of rabies, no less than 41 cases were reported in districts extending 200 miles into the interior of the Colony. By September, 1951, the following confirmed cases had been recorded:

118 Dogs  
1 Cattle  
1 Horse  
1 Sheep

In addition, the following clinical cases had been reported:

273 Dogs  
14 Cattle  
8 Cats  
7 Wild Dogs
An attempt was made to stop the spread of the disease by adopting the following measures:

1. Tying up all dogs within a 20-mile radius of an infected spot,
2. Destruction of stray or ownerless dogs,
3. Compulsory reporting of suspicious symptoms and deaths,
4. Building up a diagnostic service, and
5. Reduction of wildlife (jackals, civet cats, etc.).

However, the professional staff responsible for carrying out the program soon reported that control of rabies under these conditions was impossible, and advocated the destruction of all dogs in infected areas. Such a policy would not have been acceptable to the government nor to the general public. As an alternative, the policy was adopted of vaccinating all dogs in infected areas with Flury living virus chicken embryo vaccine, and this was begun in July, 1951. For several months, vaccination was confined to the rabies-infected areas. The infection spread so widely, however, that it became necessary to place the entire country under quarantine, and an attempt was made to vaccinate every dog in the country. Actually, over 208,000 dogs, representing 75-80 per cent of the entire dog population, were vaccinated and tattooed. Up to 1953, a total of 388 cases of rabies were confirmed in the following species:

- 310 Dogs
- 35 Jackals
- 7 Sheep
- 2 Rattles
- 7 Cats
- 19 Cattle
- 2 Horses
- 3 Civet cats
- 2 Badgers
- 1 Baboon

Confirmed cases of rabies were reported in 53 vaccinated dogs.

It is interesting to break this figure down according to the time interval following vaccination:

- 10 cases, less than 1 month
- 9 cases, 1-3 months
- 5 cases, 3-6 months
- 8 cases, 6-9 months
- 7 cases, 9-12 months
- 7 cases, 12-18 months
- 7 cases, unknown

Taking into consideration the long incubation period of rabies, it is possible that natural infection might have taken place in the 24 dogs which developed rabies within six months of vaccination. Subtracting these and the seven cases of unknown...
incubation, there were 22 cases in 208,000 vaccinations, an incidence of .0105 per cent. If the total of 53 cases in vaccinated dogs is taken, the figure is 0.025 per cent.

There is another factor to be considered, in addition to the possibility of pre-vaccination infection, in assessing vaccination failures; it is the possibility of human error in the vaccination procedure. A vaccination campaign carried out under tropical or subtropical conditions, and involving the use of a living virus vaccine transported over long distances, may well involve some failures. In any event, two years have now passed since vaccination was begun, and no significant waning of immunity has been observed. At least 17 districts previously heavily infected have had no rabies cases for more than a year. A few other districts, after being free from the disease for a year or more, apparently now show sporadic rabies cases, sometimes—but not always—in vaccinated dogs. The present policy in these districts is to revaccinate all dogs within a 15 mile radius of an outbreak.

The general situation in Southern Rhodesia as a whole is said to be satisfactory, although no claim can be made that the disease is near to eradication. It is thought that to reduce infection to a minimum in areas of exceptionally high incidence, all dogs will have to be revaccinated at certain intervals. Dr. J. S. Adamson, (15), has stated that he felt that the use of the Flury strain living virus vaccine "brought order out of chaos" in controlling rabies in Southern Rhodesia, and that "the benefit accruing from vaccine immunity should be incorporated into both domestic policies on rabies control and territorial policies on movement of dogs, having due regard, however, to the long incubation period of the disease."

MALAYA

Another important and interesting program was undertaken in Malaya. Again, as in Israel, the World Health Organization sponsored the project, and mass vaccination of dogs was coupled with legally enforced control measures and carried out on a nation-wide basis (12, 16). Ninety-five per cent of all laboratory-confirmed cases of rabies in animals in Malaya since 1924 have been in dogs. Since jackals, wolves, foxes and vampire bats are not found in that country, the dog is thus the chief—if not the sole—vector of rabies. The disease has been recognized at a significant enzootic level in the northern part of the country since 1924. Late in 1945, the incidence of the disease rose markedly simultaneously with the reoccupation of Malaya by Allied Forces, many of whom came from India and brought their dogs with them. For the years 1946 through 1951, the average number of confirmed rabies cases was 112 per year. For 1952 the total was 198. In April, 1952, a fulminating outbreak, constituting a serious extension of the enzootic southward, occurred in the Federal capital of Kuala Lumpur (population, 250,000). This outbreak precipitated the decision to introduce compulsory vaccination of all dogs.

Compulsory vaccination was started in August, 1952, with 18,000 dogs in the Kuala Lumpur area receiving live virus chicken embryo vaccine (Flury strain), and 12,000 dogs in the most seriously infected areas of Perak, the State with the worst post-war record of rabies, receiving phenolized buffalo brain-tissue vaccine.
In January, 1953, a federally sponsored compulsory vaccination campaign, using Flury strain chicken embryo vaccine alone, was initiated simultaneously in all rabies-infected states, and continued through July, 1953. Young dogs were vaccinated as soon as they reached four months of age. The regulations requiring vaccination were coupled with a well-organized educational program using every available publicity medium.

An outbreak of rabies involving two known cases in dogs occurred in May, 1953, in Singapore Island. Compulsory vaccination on a limited scale was introduced, and the outbreak was promptly controlled.

From August, 1952, to November, 1953, a total of 114,000 dogs was inoculated with chicken embryo vaccine in the Federation of Malaya and Singapore. Rabies was subsequently confirmed in only eight cases, as follows: 1, one week after vaccination; 2, two weeks after vaccination; and 5, three weeks after vaccination. In comparison, of 27,500 dogs vaccinated in August-December, 1952, in Perak with a single dose of phenolized 20 per cent brain-tissue suspension vaccine, 24 cases subsequently developed confirmed rabies in a period from the first through the 35th week following vaccination. These results indicated that—under Malayan conditions at least—the Flury strain vaccine brought about a more rapid improvement in the general picture, with an apparently longer period without reappearance of the disease, than was achieved by the phenolized brain-tissue vaccine.

No cases of rabies in man or animal have been reported in Malaya for the period of June through December, 1953—the latest figures available.

The success of the compulsory vaccination measures adopted during 1952-1953 made it possible to modify the veterinary sanitary laws governing the admission of dogs into the Federation from rabies-infected countries, and the movement of dogs between rabies-infected and rabies-free states within the Federation. Briefly these modifications are as follows:

1. Dogs from rabies-infected countries are allowed to enter the Federation provided they are vaccinated with chicken embryo vaccine and ear-tattooed immediately on arrival, and are subsequently quarantined for 30 days.

2. Dogs from rabies-infected communities within the Federation may be moved to rabies-free areas under the conditions stated under 1 above, or after spending 90 days in the state in which they were vaccinated subsequent to being vaccinated with chicken embryo vaccine and being tattooed, but with no quarantine.

In order to maintain the improved situation with respect to rabies in Malaya, compulsory vaccination of all dogs in the Federation went into effect on January 1, 1954. Areas are included in which vaccinations were made in 1952 and 1953. It was estimated that approximately 120,000 dogs would be vaccinated with chicken embryo vaccine during 1954; 100,000 of them by the middle of March. The minimum age for compulsory vaccination was reduced to three months. It is felt that if freedom from rabies is maintained during 1954, it may be possible to limit compulsory vaccination in subsequent years to a belt approximately 30 miles wide along the Malaya-Thailand border.

Altogether, more than 2,000,000 dogs throughout the world have been immunized with the Flury strain of chicken embryo adapted vaccine. It is gratifying
to review the progress which has been made in the control of rabies, and to report on mass vaccination programs in which potentially explosive outbreaks were prevented.

REFERENCES

REPORT OF THE COMMITTEE ON RABIES

V. D. CHADWICK, Jackson, Mississippi, Chairman; A. L. BRUECKNER, Baltimore, Maryland; G. EICHORN, Indianapolis, Indiana; H. R. COX, Pearl River, New York; T. B. CLOWER, Atlanta, Georgia; J. H. SCHALL, Harrisburg, Pennsylvania; H. W. SCHORNING, Washington, D.C.; E. TIERKEL, Atlanta, Georgia.

The incidence of rabies for the country remained about the same as it has been for the past few years, with the over-all picture not changed any for a national program for eventual eradication. Today more advancements have been made in research, and knowledge of the best means of combatting rabies is now available which should be used to the best advantage for the control and eradication of rabies in this country.

Rabies control programs have been carried on in foreign countries with very successful results, reducing significantly the incidence of the disease. With proper education and public relations throughout this country, similar sound programs can be carried out to good advantage for the mutual benefit of man and animals.

Rabies held the international limelight on three occasions during the past year. It served as one of the topics in the virus section of the XV International Congress at Stockholm in August, 1953. There was a complete section devoted to rabies at the VI International Microbiological Congress at Rome in September, 1953. The Second Session of the World Health Organization Expert Committee on Rabies was

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Alaska reports no "positive" findings for rabies in animals for the calendar year 1953.
Hawaii reports that rabies has never occurred in the Territory.
Puerto Rico reports 11 dogs, 1 cat, 9 cattle, 4 horses, and 37 mongooses.

Note: 1952 incidence figures for Alaska received too late for report. Alaska, calendar year 1952, had positive cases of rabies in 3 foxes and 1 dog.
held in Rome, September, 1953. Much of the material contained in this report will be based on the deliberations of the WHO Expert Committee.

In the United States, two regional conferences on rabies were held during the past year, one at Tampa, Florida in March, 1954 for the Southeastern region and one in New York City in April, 1954 for the Middle Atlantic States.

Perhaps the most important incident since submission of the last report was the discovery of rabies in insectivorous bats for the first time in the United States. The initial episode occurred in June, 1953, when rabies virus was recovered from a Florida yellow bat (Dasypterus floridanus) after it had attacked a child near Tampa. A subsequent survey in the area revealed the infection in five yellow bats (Dasypterus floridanus) and one Seminole bat (Lasiurus seminole). The second episode occurred near Carlisle, Pennsylvania, where the infection was found in a hoary bat (Lasiurus cinereus) after an unprovoked attack on a woman in that area. The latest isolation of virus from bats was in Texas early in 1954 when the infection was found in two Mexican free-tailed bats (Tadarida mexicana). The questions which these findings pose are many and they include the importance of bats as a reservoir, the relationship between the infection in these insectivorous flying mammals and the terrestrial sylvatic problem and also with the vampire bat problem in Latin America. The epidemiological significance of the bat rabies problem in the United States is now under investigation.

Your Committee on Rabies recommends:

(1) That there is a great need for a national program established on a sound basis.

(2) In areas of enzootic or epizootic canine rabies, a well-organized intensified program of mass immunization be inaugurated by immunizing at least 70 per cent of the entire dog population in the shortest possible period of time.

(3) Recognizes that the chicken embryo vaccine (Flury strain) produces excellent immunity in dogs for at least three years following a single intramuscular inoculation (posterior thigh muscles) and recommends the use of this vaccine in rabies immunization programs.

(4) More cooperation between all agencies interested in the control of rabies.

(5) That states report to one another of the occurrence of positive cases from those counties on the state line so that the adjoining state could alert the county or counties to the situation.

INCIDENCE OF RABIES IN THE UNITED STATES, CALENDAR YEAR 1953*

Statistics on the number of cases of rabies in the United States in the calendar year 1953 have been collected by the Animal Disease and Parasite Research Branch, Agricultural Research Service, U. S. Department of Agriculture.

There were 8,837 cases reported. There were 5,688 cases in dogs, 538 in cats, 1,012 in cattle, 21 in horses, 42 in sheep, 38 in swine, only 5 in goats, and 14 cases in man.

In response to numerous requests, a breakdown of the miscellaneous category was made, listing the animals mentioned most frequently in previous years reports. A total of 1,033 foxes was reported, with skunks being next with 319 cases.

* Data received from Alaska, Hawaii, and Puerto Rico are given on page 359.
TABLE 3
Information Collected by the Agricultural Research Service, United States Department of Agriculture on Incidence of Rabies in the United States

Distribution of Rabies by States for the Period 1946-1953, Inclusive

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This material was compiled from a questionnaire sent by the Branch to the livestock sanitary official and the health officer in each State. In some instances, data from both sources in a State were used. When there was a difference in the number of cases reported for the same species, the greater number was used, since it is believed that the reported cases do not represent all of the cases that occurred.

Table 2 gives the number of cases reported in each State by species.
OBSERVATIONS ON INFECTIOUS ATROPHIC RHINITIS

W. P. SWITZER, D.V.M., M.S.*

Infectious atrophic rhinitis of swine was first reported in 1830. Since then numerous research workers have attempted to elucidate its etiology. Recently there have been several theories advanced concerning the cause of this disease. Undoubtedly much of the research work conducted on this disease will fit into a general scheme when we have additional knowledge, but at the present time more facts must be known before we understand the cause of this disease. There is a distinct possibility that more than one agent may produce turbinate atrophy. Therefore the divergent reports on the etiology of infectious atrophic rhinitis may correlate better as we gain an understanding of this disease.

Observations made on infectious atrophic rhinitis in the laboratory and in the field over a period of time cause considerable doubt that it is primarily responsible for the economic loss some have attributed to it. Swine herds have been observed with severe sneezing and severe turbinate atrophy present, and according to the owner's evaluation have made satisfactory gains. On several occasions moderate turbinate atrophy and sneezing have been detected in herds of swine that the owners thought were normal. On the other hand many swine herds have been encountered that were very unthrifty and infected with infectious atrophic rhinitis. The difficulty in evaluating the cause of the pigs' unthriftiness is that almost always some other disease is present in these animals besides turbinate atrophy. This brings up the very basic question of just how much of the unthriftiness is due to infectious atrophic rhinitis. Most research workers agree that the one most characteristic lesion of this disease is an atrophy of the nasal turbinates. It has been observed that herds with no significant lesions other than atrophy of the nasal turbinates usually present a minor economic problem to the farmer. It is when turbinate atrophy is associated with severe bronchial pneumonia or other diseases that the pigs become unprofitable. The cause of the pneumonia appears to be distinct from the cause of turbinate atrophy. Under farm conditions when pneumonia is superimposed on turbinate atrophy the pneumonia becomes more severe. The condition diagnosed in the field as atrophic rhinitis is frequently a combination of several disease processes. I do not believe we adequately understand these various conditions but it appears to me that turbinate atrophy by itself is of little economic significance, except that it predisposes the pigs to pneumonia and other infections. The cause of pneumonia in these pigs is unknown although it resembles virus pneumonia of pigs originally described by English research workers.

Infectious atrophic rhinitis appears to be spread by aerosols of infective droplets being inhaled by young pigs. Environmental conditions which favor aerosol transmission such as high humidity in a closed building housing a large number of closely-quartered, infected sows and susceptible baby pigs seems to produce the most severe natural cases. It has been observed that the early spring pig crop generally has more severe turbinate atrophy than the late spring pig crop. It seems logical that the dif-

* Veterinary Medical Research Institute, Ames, Iowa.
ference in climatic conditions and husbandry practices is responsible for the variation in the rate and intensity of exposure.

When we think of an infectious disease we usually expect it to be transmitted by a single exposure. However, with infectious atrophic rhinitis it is apparently possible to influence the degree of lesion produced in the inoculated pigs by varying the number of exposures they receive. Most investigators working with this disease have used multiple inoculations to produce distinct turbinate atrophy. This same factor appears to work in the natural transmission of the disease.

It apparently has been possible to prevent the transmission of infectious atrophic rhinitis from infected sows to their pigs by taking the pigs from the sow when 18 hours or less of age and rearing them by hand in isolation. Currently an attempt is being made to apply this information to the elimination of infectious atrophic rhinitis from a valuable breeding herd. The results obtained by this herd owner to date are very encouraging but it is still early to be certain that he has completely eliminated the disease from his herd.

Another control measure that appears to markedly reduce the severity of this disease is the farrowing of individual sows in isolated surroundings. Although some sows in an infected herd do not infect their litters when this type of management is used, others will transmit mild cases of turbinate atrophy to their pigs. Therefore this method can only be considered to control the disease and not to eradicate it.

The separation of infected pigs from noninfected sows and litters by a 30' lane has prevented spread of this disease. However, when baby pigs were reared by hand in an inside pen adjacent to infected pigs, some of the baby pigs developed the disease. In this case a $3\frac{1}{2}'$ high solid tile block partition separated the two pens. This suggests that direct contact between infected and susceptible pigs is not necessary for the transmission of this disease, but that a relatively short distance stops its transmission.

When penicillin or aureomycin was fed to baby pigs it did not prevent the development of turbinate atrophy. However there is no doubt that many veterinary practitioners have obtained improvement in unthrifty pigs affected with turbinate atrophy and other disease syndromes by feeding various antibiotic preparations.

Infectious atrophic rhinitis is so widespread in the Corn Belt that the introduction of quarantine measures against it, if applied to all herds where turbinate atrophy can be detected, would not be economically feasible. We must work out an adequate eradication program, and have source herds free of the disease from which the commercial producer can obtain his replacement stock, before we think in terms of quarantining herds infected with this disease.
LEPTOSPIROSIS IN SWINE


Leptospirosis in swine has been recognized only recently in the United States (1, 2, 3). Furthermore, it appears to be widespread, at least in the mid-west. We are concerned with this disease, not only from the standpoint of illness which it may produce in swine, but also because of the role which such infected animals play in the transmission to other animals and also to man.

In order to avoid possible confusion, the terms "leptospirosis in swine" or "swine leptospirosis" should indicate infection with a member of the genus, Leptospira. There are several species of leptospiras—Leptospira canicola (4), L. hyos (5), L. icterohaemorrhagiae (6, 7) and L. pomona (8)—which, under natural conditions, are capable of infecting swine. However, L. hyos has not been described as occurring in the United States.

Information (7) available at present would indicate that in the United States the most important species infecting swine is L. pomona, although there is need to investigate further the types and incidence of infection with other species. This report will deal almost exclusively with L. pomona.

Leptospirosis in swine appears to be rather widespread in the mid-west as judged by a few surveys that have been made. Bernstein and Baker (9) reported that of 285 swine serum samples collected in the mid-west, 22 per cent were serologically positive with L. pomona. Of 500 serum samples collected in a random fashion from swine originating in Ohio, our laboratory has found three per cent similarly positive. This compares favorably with a recent survey conducted by the Ohio Division of Animal Industry (10) which revealed that of 10,000 bovine serum samples tested, 4.12 per cent were serologically positive. Antibodies for L. pomona have been detected in three of four brands of commercial hog cholera antiserum (7). This, in itself, is indicative of its wide prevalence.

The information on infection of swine with L. pomona—occurring either under natural or experimental conditions—would indicate that the clinical signs are very slight and transitory, except in pregnant sows in which case abortion and death of new-born pigs may occur. A high rate of abortions has been observed in several herds of swine (11, 12, 13). For abortion to occur, it is felt that infection of the sow must take place during pregnancy. In most cases sows abort during the last two weeks of the gestation period. Sows that have aborted once due to leptospirosis have not been observed to do so again from this disease. It is our belief that abortion occurs as the result of leptospira organisms passing from the blood stream of the sow, during the leptospiremic phase of the disease, to the fetuses where infection may lead to death and subsequent abortion.

When swine are artificially infected with L. pomona, the course of events, as commonly observed, are as follows (8, 13, 14): A leptospiremia of about four to

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six days' duration is established. A febrile reaction, as well as inappetence, for one to two days may be observed during this period. The organisms then tend to become localized in the kidney, in all probability in the lumen of the uriniferous tubules. Leptospiiras may then be eliminated in the urine of these apparently healthy swine for a variable period of time, possibly for one year. These animals may then serve to transmit the disease not only to other swine but also to cattle, horses, sheep and man.

We have been somewhat surprised by our inability to consistently produce a readily detectable leptospiruria in artificially infected swine. The first group of about 20 swine which we infected exhibited great numbers of leptospira organisms in their urine so that a darkfield examination of the urine appeared as a culture of leptospira. Since then we have not been as successful and have been interested in the explanation for this apparent discrepancy. Consideration has been given to a possible alteration in the characteristics of the leptospira organisms, and also to the possible effect of feeding and management of the swine. Leptospira organisms are killed when exposed to a low pH, and it is possible that the pH of swine urine could be affected by feeding.

Recently, leptospirosis was diagnosed in one of the largest so-called "pig hatcheries" in the mid-west (13). The diagnosis was made as a result of the investigation on the cause of a number of abortions that were occurring. It was then found that infection was rather widespread among the swine on this large farm. This establishment was selling weanling pigs throughout the mid-west, and thus there was an opportunity for a rather widespread dissemination of the disease.

In an attempt to control or regulate leptospirosis in domestic animals, knowledge concerning its mode of transmission is of great importance. Of special importance is information regarding the reservoirs of *L. pomona*. Of the domestic animals, swine appear to be of the most importance as carriers since they will apparently eliminate leptospiras in their urine for a longer period and in greater numbers than the other animals. However, little information is available on the possibility of rodents, such as field mice, serving as reservoirs. This is a problem that surely needs further attention. With some species of leptospiras—such as *L. grippotyphosa*—field mice serve as the primary reservoir. Of importance also is information on factors contributing to transmission, such as: the role of streams, ponds and surface water; the time of year, temperature of the soil and water; the length of survival and possibility of multiplication of the leptospiras in surface water. Leptospiras are readily killed upon dessication and in this respect they resemble the spirochaete causing syphilis. In all probability streams of water play an important role in the transmission of this disease from one farm to another. The role of the boar in the transmission of the disease to sows is a definite possibility and should receive further study. Gilts have become infected by the introduction of *L. pomona* organisms in the conjunctival sac, the nose, and the vagina (13).

In the diagnosis of leptospirosis, there are available reliable serologic tests. One in particular, the agglutination-lysis test, is very sensitive and accurate. However, a serologically positive animal may not necessarily be a carrier.

Very little information is available on the value of a *L. pomona* bacterin in swine.
There is some reason to believe, however, that it could be of value, especially when used on susceptible gilts being introduced into an infected herd.

The value of chemotherapeutic agents on the destruction of the leptospiras localized in the kidneys of infected swine apparently has received little attention. One may conjecture that, as has been found in other animals, streptomycin and aureomycin should be effective.

The significance of this disease in man—known in Europe as swineherd's disease—has not been evaluated in the United States. We may have to await this evaluation before we can thoroughly gauge the attention which should be given to this disease in swine.

In the attempt to curb the dissemination of this disease, attention is called to the following suggestions: (1) the use of immunizing agents in exposed susceptible animals; (2) use of appropriate chemotherapeutic agents to destroy the leptospiras in the kidneys of carriers; and (3) preventing the entrance of infected animals, especially boars, into clean herds by the use of a routine serologic test, such as is done in the case of brucellosis.

BIBLIOGRAPHY


The Ohio State University.
REPORT OF COMMITTEE ON TRANSMISSIBLE DISEASES OF SWINE

J. D. Ray, White Hall, Illinois, Chairman; Jerome Beller, Courtland, Virginia; H. U. Garrett, Des Moines 19, Iowa; J. L. George, Lincoln 1, Nebraska; Joseph W. Green, Indianapolis 7, Indiana; James R. Hay, Columbus 15, Ohio; A. H. Quin, Kansas City, Missouri; L. A. Rosner, Jefferson City, Missouri; and William L. Sippel, Tifton, Georgia.

Your committee has attempted to obtain a comprehensive picture of the transmissible disease problem in swine for the United States and Canada. However, it has not concerned itself with diseases which other committees of the Association will cover, such as brucellosis, vesicular diseases, tuberculosis, parasitic, etc. Livestock Sanitary officials of the 48 States and the Canadian Department of Agriculture were communicated with and a response was received from 46 States and Canada. These responses are submitted in summary.

HOG CHOLERA

The incidence of hog cholera was reported as unchanged by 20 States, and the disease decreased in incidence in 22 States. Four of the principal swine producing States reported a decrease. It is significant that no State experienced an increase of the disease this year. Canada reported the incidence as nil.

Notations on a few questionnaires indicated that some officials thought the decrease in hog cholera was due, in part, to the diminished use of virulent virus in immunization procedures.

The committee feels that much work needs to be done on the problem of breaks following the vaccination of swine with the various agents available and commonly used. We need to learn why one herd will respond and develop a satisfactory immunity, while another that appears to be identical in all respects will fail to develop a lasting immunity when the same product is used on the two herds.

We call your attention to two important papers on this program: Hog Cholera Eradication at County Level, by Dr. C. L. Campbell, and the Report of the Committee on the Nation-wide Eradication of Hog Cholera, by Dr. L. M. Hutchings.

SWINE ERYSIPelas

The swine erysipelas situation in this country changed materially during the year. Fifteen States reported an increase of this disease and five of these major swine producing States. No major swine producing State reported a decrease during the year. No change in incidence was reported by fifteen States. However, six States outside the principal swine raising territory experienced a decrease, and six other States in this group reported erysipelas had not been diagnosed. Canada reported that the disease was frequently observed. Your attention is directed to publications that have appeared during the year that deal with the immunization of swine against swine erysipelas. The articles by Dr. Richard D. Shuman and associates are of special interest where gilts and sows are immunized near breeding.
area were set up as follows:
(1) The area should contain a concentrated swine population where cholera has been known to exist.
(2) The area should be adjacent to a similar swine raising area for comparative purposes.
(3) Geographical boundaries should isolate or set off the area to the degree that provisional quarantine measures could be effectively practiced, if necessary.
(4) The supervision of the swine vaccination program in the state should be under adequate regulatory control.
(5) The area should be in a state which could restrict the use of virulent virus where needed.
(6) Consideration should be given to the adequacy of the state's swine garbage feeding program.
(7) The cooperation of farmers, veterinarians, and the general citizenry of the area with the will to do the job would be essential to the success of the project.

The conclusion reached by the committee at this first meeting was that the purpose of the project was to determine not what method of immunization to use, but primarily what sound disease eradication measures should be employed that would be practical when applied on a national scale.

By exchange of correspondence from last October to March of this year, the six-man committee was able to eliminate certain areas of the country which could not meet all of the given conditions, and it was decided that a meeting should be called for the purpose of making final selections and to draw up details of conducting the project. Meeting with the sub-committee in Chicago were representatives of the commercial concerns who had been invited to discuss the merits of the various anti-hog cholera products.

During the discussions it was brought out that in as much as the State of Alabama was practicing a program which incorporated the use of crystal-violet vaccine in its hog cholera immunization plans and which program entirely excluded the use of virulent virus, that this state would serve as one of the evaluation areas.

Earlier consideration had been given to the selection of adjacent Suwannee and Hamilton counties in Florida as a pilot test site since they, as well as the state in general, met the specified qualifications of a test area. This was particularly true with reference to the geography of both these counties and the state in that they were surrounded on all sides but one by water which condition would lend itself to relative ease of provisional quarantine enforcement; also, since the distribution of state-purchased anti-hog cholera products was relegated to approved administrators through the office of the State Veterinarian, the supervision of the cholera program would be under adequate regulatory control. Further, a great deal of interest and evidence of cooperation had been exhibited by the swine industry and veterinarians throughout the state.

Following the selection of these counties the committee set up its modus operandi for the area. The test was to be conducted in two phases: the first stage which would probably extend over a period of a year until federal money could be made avail-
able would provide for a planned educational program with farmers and veterinarians in which sound disease eradication procedures would be taught. This would also include the selection of herds in which swine would be vaccinated and later challenged to demonstrate developed immunity, the showing of films on cholera, the distribution of literature on the disease, discussions with Farm Bureau, 4-H and FFA, and other agricultural groups, as well as individual contacts in order to thoroughly acquaint them with the disease and the ultimate benefits of a complete eradication program. The logic behind this is, of course, evident in that the farmers and general public would not find it as difficult to progress into the second phase of the project which would entail the following points:

1. A comparable program would be established in each county with Suwannee using modified virus and Hamilton virulent virus.

2. Statistical data would be maintained so that a complete evaluation could be made of the program.

3. Provisional quarantines would be established to control the movement of unqualified swine between and into these counties to prevent the introduction of cholera.

4. Diagnostic laboratory facilities would have to be made available in confirming field diagnosis of the disease.

5. In herds where hog cholera developed, sick animals would be isolated from those which were apparently not sick and slaughter made of the affected swine. (Indemnity would have to be provided for slaughtered hogs, probably from appropriated federal funds.)

6. Thorough cleaning and disinfection of diseased premises would be mandatory.

The question of financing the project then came under consideration. The representatives of the commercial producers present felt that their companies would be in a position to furnish a pro-rated share of free vaccine for the Suwannee County area; however, not wishing to establish a precedent which might have an adverse effect in the eventual expansion of the program, the sub-committee decided against soliciting these products. As a matter of information, the Florida Livestock Board has since resolved this problem in expanding its purchasing policy wherein modified virus vaccine is now available to farmers in that county without cost.

In the ensuing discussions regarding the use of federal funds for implementing the test project, it was concluded that with proper endorsement by the United States Livestock Sanitary Association and its component members Congress should, in view of its national import, be favorable toward releasing sufficient funds for conducting the program. A budget was prepared listing the estimated annual expenditures in the Pilot Test Area by the Florida Livestock Board and sent to the Secretary of Agriculture for his consideration in recommending the release of matching federal funds for the project. Word has since been received from the Agricultural Research Administration that careful attention would be given to the request of $117,000 in developing the budget to be submitted to the next Congress.

In the interim the program has been launched in the Pilot Test Area. We have had many meetings not only with agricultural and civic groups, veterinarians and individual farmers in the area, but also with allied groups throughout the state, and a great deal of interest has been apparent since the educational phase began.
in July. In the development of this project I have observed that a sound public relation or information program is most essential. A planned audio and visual education program which incorporates the use of radio and newspaper coverage, plus films, literature and field demonstrations has aided materially in acquainting farmers and the public in general of what is to be expected from them, as well as what benefits they can expect in bringing the project to a successful conclusion. As a result of this the work which we have cut out for us in expanding the program into its second phase will be much more readily accepted.

Of course, it is too early to make an evaluation of the project and to arrive at any important conclusions; however, it is interesting to note some of the developments in the two counties. Of the estimated 70,000 to 85,000 hogs in the two-county area, 50,000 were vaccinated last year. Possibly five per cent of these animals received modified live virus, the remainder serum and virulent virus. The reported outbreaks of cholera during that period in these two counties involved about 130 herds, the majority of cases being in Suwannee County. Since July 1st of this year 4,300 swine have been vaccinated in Hamilton County and somewhat over 12,000 in Suwannee. Of this 12,000 in Suwannee County, 9,000 animals received modified virus by choice of the owners. In these four months one case of cholera has been reported from the area, this being in a nonvaccinated herd. The scientific significance which may be drawn from this information would, of course, be more in the field of conjecture because of the many variables and unknowns involved. Probably this area, like a great many sections of the country, is enjoying a normal decreased incidence of hog cholera this year. Regardless of the cause, this much is certain—as far as the farmers there are concerned, for some reason their hogs aren’t dying from cholera now as they were last year. The program is getting the credit for it, and these folks are, I feel, justifiably enthusiastic about it.

The ball is now rolling toward our goal of eradication. Whether it continues to pick up momentum or is brought to a standstill, depends upon your interest in the future of this nation’s swine industry and to your active participation in the expansion of the project.

Individually, and as an association—it’s up to you.

REFERENCES


CHAIRMAN H. F. WILKINS: Thank you, Dr. Campbell, for a splendid report. We have set aside a few minutes for discussion. Dr. Campbell will remain up front so you may direct your questions to him.

VOICE: What has happened in Alabama?

DR. C. L. CAMPBELL: I wonder if Dr. John Milligan is here. He can give you a more complete picture on the Alabama situation.
Dr. J. Milligan [Montgomery, Alabama]: The program has been highly successful in Alabama. In that county in 1953 we had seven breaks—seven herds that were infected. We were able to confine those to the premises on which the disease was found.

So far in 1954 we haven't had a single break in the county. The people are very much enthused over the program, and I think it will be successful there.

Chairman H. F. Wilkins: I would like to ask one question, Dr. Campbell, relative to this national program. Is it the intent to try to encourage the special processing of exposed hogs, the same as our VE hogs at the present time? Is that one of the measures which you might expect to use in containing the further spread of the disease nationally?

Dr. C. L. Campbell: We haven't projected our thoughts that far as yet. We haven't gotten into that phase of the program. It will probably be July of next year before we get into our compulsory phase.

It sounds like a wise idea, however, in the slaughtering of these animals, to prevent any further spread.

Chairman H. F. Wilkins: As far as we are concerned in our State, we have very little hog cholera. Almost without exception the primary outbreaks are due to the feeding of uncooked pork scraps.
REPORT OF THE COMMITTEE ON THE NATIONWIDE ERADICATION OF HOG CHOLERA

L. M. Hutchings, Chairman; W. A. Aitken; James A. Baker; C. L. Campbell; B. H. Edginton; Claude Gifford; Max J. Harvey; James R. Hay; R. A. Hendershott; F. J. Keilholz; H. C. H. Kernkamp; S. H. McNutt; John G. Milligan; W. L. Plager; A. H. Quin; J. D. Ray; H. W. Schoening; E. R. Shannon; R. E. Shope; B. T. Simms; F. C. Smith

This committee was organized and presented its first report in 1951. To date progress has been quite satisfactory. Your committee considers that its work is now entering a crucial period. Unless important further progress is made promptly, there is at least danger that the move for the eradication of hog cholera will lose momentum. "Nothing stands still," will apply in this situation. Furthermore, if the enthusiasm and interest in this laudable objective does decrease as an inevitable result of lack of progress, it appears likely that much will have been lost that will be difficult to regain, at least for several years. Thereby, your committee urges all of you to individually and collectively make your contribution for further progress toward the eventual eradication of hog cholera. It can and will be done, but only if enough swine raisers and veterinarians are willing to energetically work for it.

The outstanding achievement toward this objective to date is the work in progress on a county basis in Florida. The experiences to date in this "pilot test area" have been reported to you in the previous paper.

Your committee desires to direct attention to the following pertinent data, facts and opinions on policies and procedures.

1. Eradication of hog cholera is unlikely to gain substantial momentum, particularly in the intensified hog raising areas, unless the move for it is adequately led and financed at the national level by the Agricultural Research Service of the United States Department of Agriculture. Funds could be well utilized to support the Florida project, activate additional eradication test areas, police existing regulations and pay indemnity for losses in pilot test areas. The Congress is unlikely to appropriate adequate funds for this program unless there is an effective demand originating from the swine raisers. Much effective effort has already been put forth to this end. Your committee considers that this is the key for success and urges you to help get this job done. In this regard, we should recognize that the swine raisers must provide both the incentive and the demand and that they have not done this of their own volition during the past 100 years. They have not had effective leadership toward this goal. It is likely that with proper leadership the swine industry will provide the incentive and demand needed for success. Active extension efforts may stimulate progress in this area.

2. Some State livestock sanitary officials should revise their regulations governing standards and vaccination requirements for transit swine, both for intrastate and interstate movement.

3. Hog cholera should be made a reportable disease. One of the first steps necessary in the eradication of hog cholera is to find out how numerous the enemy is and where he is located.
4. The dominant question concerning hog cholera today is: “Are the modified hog cholera vaccines as good as, better than, or less effective than serum and fully virulent virus in the prevention of hog cholera?” Unfortunately, it is not possible to definitely answer this all-important question at this time. The answer will come with continued use of the modified hog cholera vaccines and the passage of time. Perhaps in the evaluation of hog cholera control methods one should keep in mind that field outbreaks of the disease have followed a rather cyclic pattern with peaks occurring at approximately seven- to ten-year intervals. There were extremely serious losses in 1913, 1926, 1949 and 1950. The cycles seem to occur without respect to the amount of vaccination and thus should be taken into account when attempting to evaluate the new vaccines. In other words, we likely will not have the full evaluation of the newer immunizing products until after we have had an opportunity to observe what happens during the next “bad year” in these hog cholera cycles.

5. The original hope and claim was that these new forms of virus would be totally incapable of producing hog cholera. It will probably be accepted without challenge that the modified viruses are not as infectious or as invasive as fully virulent hog cholera virus. This lesser degree of infectivity will likely give the modified vaccines a definite advantage over antiserum and fully virulent virus in efforts to eradicate hog cholera. It is not yet clear, however, whether or not all of the new products will prevent the spread of cholera to unvaccinated pigs under all circumstances.

6. The volume of production of fully virulent hog cholera virus has been decreasing steadily, whereas there have been increases for the newer vaccines during the past three years. These figures are presented in Table I. A recent poll indicates that about four out of five farmers are having swine vaccinated for cholera in the ten top swine-producing states; of these, 45 per cent use virulent virus and serum; 32 per cent use modified live virus with serum; 13 per cent use modified live virus without serum; and 10 per cent use tissue vaccines.

7. There is need for more research on hog cholera to fill in important gaps in our knowledge. Your committee recommends that the Agricultural Research Service of the United States Department of Agriculture include in its 1956 budget requests for ample funds for rehabilitation and expansion of the Federal hog cholera station near Ames, Iowa, into an adequate research center for studies of hog cholera. All other suitable animal disease research agencies should be encouraged to renew and/or expand their studies of this disease.
A CONTRIBUTION TO THE STUDY OF VESICULAR STOMATITIS IN MEXICO*

FERNANDO CAMARGO N.

Mexico City, Mexico

HISTORY

In view of the importance represented in the establishment of a precise differential diagnosis between Vesicular Stomatitis and Foot-and-Mouth Disease, from June 1949 and as a necessity resulting from the Campaign being carried out in Mexico against the latter disease, the Laboratory for the Diagnosis of Vesicular Diseases was established, especially for the diseases mentioned, which fell under the Department of Investigation and Vaccine Production of the Mexico-United States Commission for the Eradication of Foot-and-Mouth Disease, under the denomination of Serology and Type Screening Units.

Upon termination of the campaign, in September 1952, and disappearance of the Commission for the Eradication of Foot-and-Mouth Disease, this Laboratory was made a part of the Commission for the Prevention of Foot-and-Mouth Disease, under which it has been working to date.

Before July 1949, on which date the Laboratory was established, the differential diagnosis of vesicular diseases was made by the General Direction of Animal Investigations, of the Department of Agriculture and Promotion; little work on this matter was done at this Direction due to the existing working conditions in Mexico, but it must be stated that the work was for the purpose of establishing a differential diagnosis in those cases where the epizootiological and clinical history led one to suspect the possibility of the existence of foot-and-mouth disease in the country.

It should be made clear that, previous to 1949, the diagnoses in cases of vesicular diseases, were biological, and that due to the lack of facilities, once the presence of the virus was determined, it was not typed.

As already stated, in July 1949 and with the operation of the new Laboratory for the Diagnosis of Vesicular Diseases, the work-plan for the establishment of these diagnoses was greatly modified due to the following circumstances:

1st—The activities in the field to locate suspicious cases of vesicular disease were increased to a maximum, as a result of which a great number of samples were received at the laboratories.

2nd—By orders from the Main Office of the Campaign against Foot-and-Mouth Disease, and in accordance with the latest knowledge on the matter and the procedures used in specialized research centers, it was accepted that for the establishment of a differential diagnosis of vesicular diseases, the procedure should be a complement-fixation serological test, supported by biological methods; thus the establishment of the diagnosis in a peremptory manner was achieved, greatly

* Work presented by Dr. Fernando Camargo N. to the Committee on Vesicular Disease, U. S. Livestock Sanitary Association (Comité de Enfermedades Vesiculares, Asociación Ganadera Sanitaria de los Estados Unidos de Norte América).
facilitating the operations of the campaign, and simultaneously obtaining the
typing of the virus which caused the disease, since all the samples received by the
Laboratory were tested against specific anti-sera of foot-and-mouth disease and
vesicular stomatitis, the latter produced by the United States Bureau of Animal
Industry.

Thus, from June 1949 to date, work has been carried out at the Palo Alto Lab-
oratories, which we briefly summarize in the present study.

LABORATORY WORK

Reference is made here strictly to work carried out at the Laboratories under
the jurisdiction of Palo Alto Research Center.

From July 7th, 1949, date on which the systematic work for the diagnosis of ve-
sicular diseases began, to August 31st, 1952, when the Mexico-United States Com-
mission for the Eradication of Foot-and-Mouth Disease completed its activities (3
years and 23 days) 1073 samples (an average of 29 samples per month) from sus-
picious animals were received from the field for the establishment of a diagnosis.

Out of the 1073 samples received, 633 were diagnosed as vesicular diseases; 395
gave negative results, and the other 45 were not suitable for diagnostic tests (58.99
per cent with positive results, 36.81 per cent with negative results, and 4.19 per
cent with no results because the samples were not tested). It must be explained
that in those cases where tests were not made, it was due to the following reasons:
Insufficient material; material in state of putrefaction; duplicated samples; samples
originating from equines; and other causes.

Of the 633 established diagnoses, 598 corresponded to positive cases of vesicular
stomatitis (55.73 per cent of the total of samples received and 94.47 per cent of
the total diagnoses established) 339 were of the New Jersey type (31.59 per cent
of all samples received, 53.55 per cent of the number of diagnosed cases and 56.68
per cent of the Vesicular Stomatitis diagnosed), and the remaining 259 were of the
Indiana type (24.13 per cent of all samples received; 40.91 per cent of the number
diagnosed and 43.32 per cent of the number of vesicular stomatitis diagnoses).

The remaining 35 positive diagnoses corresponded to foot-and-mouth disease
(3.23 per cent of all samples received and 5.53 per cent of the number diagnosed)
4 of the cases were classified as suspicious and 31 as clear diagnosis (0.37 per cent
and 0.89 per cent of all samples received; 0.63 per cent and 4.89 per cent of the
number diagnosed, and 11.43 per cent and 88.57 per cent of the number of foot-
and-mouth disease diagnoses).

From September 1st, 1952, when the Mexico-United States Commission for the
Prevention of Foot-and-Mouth Disease began to work, to date, May 10, 1954 (1
year and 9 months) 155 samples from the field have been received from suspicious
animals at the Laboratory for diagnosis (7.4 samples per month as an average).

Of the 155 samples received, 103 positive diagnoses were established, 49 gave
negative results, and 3 samples gave no results because the tests were not made
(66.45 per cent with positive results, 31.61 per cent with negative results, and
1.94 per cent without results).

Of the 103 diagnosed, 23 were positive to vesicular stomatitis (14.83 per cent of
all samples received and 22.33 per cent of the number of positive diagnoses established), 10 of them were of the New Jersey type and 23\(^1\) of the Indiana type (6.45 per cent and 8.39 per cent of all samples received; 9.71 per cent and 12.62 per cent of the number of positive diagnoses, and 43.48 per cent and 56.52 per cent of the vesicular stomatitis determined), the 80 remaining were positive to foot-and-mouth disease (5.61 per cent of all samples received and 77.67 per cent of the number of positive diagnoses).

If we consider the work performed at the Laboratory for the Diagnosis of Vesicular Diseases, the above given data will be greatly modified, and the following figures will be obtained:

Time of Laboratory operation, 4 years, 9 months and 23 days.
Total of samples received, 1228.
Samples received per month (average) 21.54.
Number of positive diagnoses, 736 (59.93 per cent of all samples received).
Number of negative diagnoses, 444 (36.16 per cent of all samples received).
Number of samples on which the corresponding tests were not made, 48 (3.19 per cent of all samples received).

Of the 736 positive diagnoses, the following results were obtained: Vesicular stomatitis, 621 diagnoses (50.57 per cent of all samples received and 84.375 per cent of the number of positive diagnoses). Foot-and-mouth disease, 115 diagnoses (9.56 per cent of all samples received and 15.625 per cent of the number of positive diagnoses).

Of the vesicular stomatitis diagnoses, the following results were obtained: New Jersey Vesicular Stomatitis, 349 positive (28.42 per cent of all samples received, 47.42 per cent of the number of positive diagnoses and 56.20 per cent of the number of vesicular stomatitis diagnoses). Indiana vesicular stomatitis, 272 positive (22.15 per cent of all samples received, 36.96 per cent of the number of positive diagnoses and 43.80 per cent of the number of vesicular stomatitis diagnoses).

Incidence.—Lacking precise data on the incidence of vesicular diseases in Mexico and particularly on vesicular stomatitis, we are taking as a basis the work done at the Laboratory in the last five years (4 years and 9 months) and taking into consideration the samples received by the Laboratory.

It must be explained that this work corresponds mainly to the area of activities of the Mexico-United States Commission for the Eradication of Foot-and-Mouth Disease, in the beginning, and later to those of the Commission for the Prevention of Foot-and-Mouth Disease (the estimated area of activities of the Campaign was 569,604\(^2\) square kilometers, almost one third of the Republic's total area).

This area geographically situated in the center of the country, included 17 States and the Federal District, and is where the greatest percentage of our livestock

1 We believe this figure to be 13.

2 In report dated May 3, 1951 prepared by Dr. Mulhern for Dr. Noyes it was stated: "... the entire infected territory consisting of 384,440 sq. kilometers ..."
reserves are located (the Campaign against foot-and-mouth disease included 16,000,000 head of cattle in 1948).

In covering this area, the campaign in Mexico against foot-and-mouth disease was in charge of observing vesicular diseases, and at the end (Inspection) simultaneously inspected the cattle within this area, taking biological samples from all animals presenting vesicular lesions or from lesions suspicious of vesicular disease, and forwarding them to the Investigation and Diagnosis Laboratory.

It may thus be affirmed that the incidence data obtained by the activities of the Laboratory, are those strictly corresponding to the geographical area in which the Campaign against foot-and-mouth disease was being carried out, and even if they only include one third of the country's total area, they correspond to its greatest volume of cattle.

On the other hand it must also be pointed out that we lack precise data on the incidence of vesicular stomatitis outside of the area referred to, and the few official reports to the Laboratories are those corresponding to samples received at the same Laboratories from the reduced group of Veterinarians of the Department of Agriculture and Livestock, this is why the incidence we give here is the one considered official in our country. From outside of the geographical area considered within the Campaign against foot-and-mouth disease, the laboratories received for diagnosis 8 samples, from Coahuila (north of the area), Tabasco and Chiapas (south of the area), and all of them gave a positive diagnosis to vesicular stomatitis.

Having made the above clarification, we go on to the incidence curve of vesicular diseases in Mexico, based on the samples received at the Diagnostic Laboratories, and we find that the incidence presents various increasing and decreasing phases, thus resulting in a broken curve (needle graph). It shows three great ascensional periods of rapid increase, two of which rapidly fall almost down to zero; the third falling slowly. We likewise find four lesser ascensional periods, the increment of which is slow but steady, showing corresponding periods of slow and steady incidence (plateau periods) two of which correspond to the final descent of the periods of maximum increase.

If we analyze these data and establish their relation with geographical conditions in Mexico, and specially with the geographical distribution of the disease, we notice a strong upward tendency toward the increase of vesicular diseases in Mexico, concomitant with the presence of cold and rainy seasons.

The greatest incidence of the disease occurs in the months of November, December, January and February (end of autumn and winter), and we consider that this phenomenon is greatly influenced by the pluviometric conditions of our country, since this is the time of the year in which the "Nortes" occur (climatological phenomena occurring on the East Coast, characterized by a general falling of temperature and rains); even though these phenomena are characteristic of the Gulf of Mexico, they greatly influence the climatic system of the Republic, particularly the Eastern Zone and the Central Plateau of the country, producing cold weather and several rainy periods.

These climatic conditions, specially on the coasts, cause the soil to become humid, and in some regions actually muddy or miry; this, and the decrease in the
general resistance of the animals (due to cold and humidity), we consider to have a fundamental influence on the incidence of diseases, and if we analyze the presence of another sharply ascending period in the incidence during the months of May, June, and July (normal rainy season in the country) we corroborate the determining influence of rain on the variations of the incidence.

In other words, the analysis of the incidence graph shows that there is a greater incidence of vesicular diseases during the rainy seasons, and that it is still greater during the pluviometric cycle corresponding to the winter months, due to the concurrence of a fall in ambient temperature.

We believe this phenomenon to be caused by a decrease of the resistance in the animals, and to the fact that they are forced to live on humid or frankly miry soil, which facilitates the infection and the propagation of the specific vesicular stomatitis virus.

Regarding the two types of this disease, New Jersey and Indiana, and in relation with their incidence, we shall say that their frequency occurs diversely, since if we analyze the curve, we find that when the New Jersey vesicular stomatitis' incidence increases, there is a corresponding fall in the Indiana vesicular stomatitis, with the exception of the period from May to September 1952, even though we consider this variation due to that year's irregular rainy season (high and continuous pluviometric phenomena) which caused a great predisposition for the epizootic conditions of these diseases.

A greater incidence of New Jersey vesicular stomatitis must be pointed out, and even though in the period from July 1949 to July 1950, only five cases were recorded against 147 cases of Indiana vesicular stomatitis, from that date the incidence of the New Jersey type has increased until becoming greater than that of the Indiana type, with the exception of the months of May and October 1951 and November 1952.

We have not found a definite explanation for this fact, since and with regard to geographical distribution, we are able to find both types in a certain geographical area, and the existence for alternate periods of each type is allegedly due to the natural resistance of the herds against the other type, the data gathered to date by the Laboratory do not afford all the explanation desired.

It must be pointed out that from May 1953, and taking into consideration the data obtained until May 1st, 1954, not a single case of vesicular stomatitis has been recorded at the Laboratories.

We believe this may be due to the fact that the systematic inspection performed in the field ceased upon termination of the activities of the Mexico-U. S. Commission for the Eradication of Foot-and-Mouth Disease, even though we find no satisfactory explanation for the incidence of this disease in the area in which the Commission for the Prevention of Foot-and-Mouth Disease has continued its activities.

It must also be noticed that there were several periods in which, without justified cause, one of the two types of vesicular stomatitis disappeared (Incidence Zero) to reappear later without great alterations in its curve.

From the geographical point of view, the incidence of New Jersey vesicular stomatitis, in those areas in which both types were present, was lower than that of
the Indiana type, while the opposite happened in the northern part of the State of Veracruz and in the valley known in our country as the Milk Shed of the Valley of Mexico, where the New Jersey type predominated.

It must be noted that in the southern part of the State of Veracruz, where the greater part of the cases occurred (360 cases of vesicular stomatitis), even though the incidence of the Indiana type was greater (182 cases of Indiana, and 178 of New Jersey), from an epizootiological point of view, the difference being so small (50.56 per cent Indiana vesicular stomatitis, and 49.44 per cent New Jersey type, of 360 cases in the area), this incidence must be considered similar, and if we take into account that in this area, as already said, the greater number of cases occurred, this fact greatly influences the general incidence curves, and modifies the criterion that the incidence of New Jersey type is higher than that of the Indiana type, which should be considered similar in those areas in which both types were present, the New Jersey type being predominant only because of a greater geographical distribution.

Summarizing the above given data on the incidences of the disease, we conclude that in those areas contaminated with both types of vesicular stomatitis, the incidence of both types is approximately similar, and that the curves show a greater incidence of the New Jersey type due to a larger infected area.

GEOGRAPHICAL DISTRIBUTION

As we mentioned at the beginning of the present study, the complete geographical distribution of vesicular stomatitis in Mexico is not known, since the present work on the subject corresponds to an estimated area of 600,000 square kilometers, approximately equivalent to one third of the country's total area (1,967,000 sq. km.)

Notwithstanding, as we have also said that in this area the largest percentage of our cattle reserves is to be found (16 million\(^3\) head of large animals, approximately 75 per cent of our appraisable stock), it is for this reason we believe the data we have reported is of great value, specially if we consider that this is the only data in existence on vesicular stomatitis in Mexico.

We have likewise said that the reported data correspond to the area in which the Mexico-United States Commission for the Eradication of Foot-and-Mouth Disease carried out its activities, and that there are also some data and reports referring to north and south of the area, which is a band that starting from the Gulf of Mexico and ending at the Pacific Ocean, divides the country in the middle; from these data we believe that vesicular stomatitis has a larger geographical distribution than the one we outline in relation with the zone in which the activities of the campaign against foot-and-mouth disease took place.

In order to make the description easier, we shall use the geographical division employed by the Mexico-United States Commission for the Eradication of Foot-and-Mouth Disease in its campaign, that is, describing first the diagnoses made on the material sent to the Laboratories from each one of the Districts, and later giving the same data for the Counties and States of the Republic.

\(^3\) Our figures show approximately 17 million.
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<th>Indiana Type</th>
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**Totals...**  
339  
259

Grand Totals: 339 (New Jersey)  
259 (Indiana)  
598
Mexico-U.S. Commission for the Eradication of Foot-and-Mouth Disease

Positive New Jersey and Indiana Field Samples

From No. 1 to No. 1073 (from July 7, 1949 to August 31, 1952)

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**Totals**.................................................. 339  259

Total of this list: 598 positive samples. Positive New Jersey—339
Positive Indiana —259

Total —598

The analysis of the above data on a map of Mexico, shows the following:

The geographical distribution of New Jersey vesicular stomatitis, is larger than that of Indiana vesicular stomatitis.

Both types coexist in the area corresponding to the southeastern part of the region in which the activities took place.
In the southeastern part of this zone, the Indiana type predominates, and this region might be considered free of New Jersey vesicular stomatitis, with the exception of Municipios 47 and 67 of the State of Cuerrero, where the presence of this type was proven.

Starting from an imaginary line going from North to South along the borderline of the State of Veracruz as far as an intersecting line going from West to East along the northern limit of the State of Cuerrero, we shall find exclusively New Jersey vesicular stomatitis in the region situated to the north and to the west (the largest area in the zone of activities of the foot-and-mouth disease eradication campaign in the Republic).

In subsequent studies we shall present for the consideration of this Honorable Committee complementary data of the epizootiological study of vesicular stomatitis in Mexico, as well as existing Laboratory data on the clinical, pathological and immunological aspects of the virus which cause this disease.

BIBLIOGRAPHY

All data reported in this study were taken from the files of the Department of Research and Vaccine Production. Mexican Section of the Mexico-United States Commission for the Prevention of Foot-and-Mouth Disease.—Palo Alto Research Laboratories.
VESICULAR STOMATITIS IN SWINE

H. W. Schoening, V.M.D.*

Vesicular stomatitis and vesicular exanthema, aside from the damage they occasion, are of particular importance in the United States because of their similarity to foot-and-mouth disease and the need for their differentiation from this disease. Vesicular exanthema until recently has been confined to the State of California and this disease has appeared entirely in swine. Vesicular stomatitis, on the other hand, has appeared in many of the States of the Union at various times since its definite identification in 1916 (1). Cattle and horses were involved, with only several instances of infection in swine. Following the escape of the vesicular exanthema virus from California and its appearance in many of the States, a campaign of eradication of this disease was undertaken. All cases of the disease were subject to verification by animal inoculation. Following this procedure it was noted with some surprise that vesicular stomatitis was identified in certain localities in swine in rather an extensive form. This presented a new problem in a vesicular disease control program since swine in the past have not been considered to be ordinarily susceptible to the virus under natural conditions.

With vesicular stomatitis in swine being unearthed in Georgia and North Carolina as a result of the vesicular exanthema eradication program, the question arose as to the proper method of handling vesicular stomatitis in swine. This presented quite a few problems which were given special mention by the Committee on Vesicular Diseases of the United States Livestock Sanitary Association at the meeting held at Atlantic City September 23-25, 1953, which made the following recommendation:

"It is recommended that a committee be established by the United States Bureau of Animal Industry for carrying out a field survey of VS in swine in Georgia and North Carolina. The committee might be comprised of no more than one Bureau representative and no less than two representatives of states having experience with VS. After a thorough epizootiological study of the disease, the committee should submit recommendations relative to appropriate means of dealing with the problem."

The Bureau of Animal Industry and its successor, the various Branches of the Agricultural Research Service, asked the following persons to serve on a committee: Dr. T. B. Clower, Georgia: Dr. James B. Henderson, Texas: Dr. W. L. Bendix, Virginia: Dr. H. J. Rollins, North Carolina: Dr. C. A. Brandly, Wisconsin, with H. W. Schoening, Agricultural Research Service, United States Department of Agriculture, as chairman. Correspondence has been exchanged between the members of the committee. It has not been possible to have a meeting nor has it been possible to make an epizootiological study of the disease because of a lack of finances. The committee's activity at the moment is limited to the following report:

Vesicular stomatitis in horses and in cattle has been reported in the United

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States for many years, but there are only limited accounts of the disease appearing in swine. It has been shown experimentally that swine are susceptible to the virus of vesicular stomatitis by several routes of inoculation of the virus and that the disease has been known, under experimental conditions, to spread rather slowly from swine to swine by direct contact. The literature records outbreaks of vesicular stomatitis in swine in Mesa and Delta counties in Colorado in 1943 and 1944. These cases, however, were not confirmed by laboratory tests. Severe outbreaks of the disease occurred in cattle and horses at that time in Colorado (2).

An outbreak of vesicular stomatitis in swine, confirmed by laboratory diagnosis to be the New Jersey type, was reported in 1943 in Missouri in a hog cholera serum plant (3). This was quite a severe outbreak and appeared in a group of hogs which were being hyperimmunized with hog cholera virus. The source of this infection was never determined.

It has been reported by Hanson (4) that vesicular stomatitis in swine was diagnosed in South America—in Venezuela in 1941 and in Colombia in 1943.

### Outbreaks of vesicular stomatitis in swine in the United States

<table>
<thead>
<tr>
<th>Location</th>
<th>Month and Year</th>
<th>Diagnosis</th>
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<tr>
<td>Colorado</td>
<td>July–Sept., 1943–44</td>
<td>Clinical</td>
</tr>
<tr>
<td>Missouri</td>
<td>August, 1943</td>
<td>Animal Inoc.</td>
</tr>
<tr>
<td>Georgia</td>
<td>May to August, 1952–1953</td>
<td>Animal Inoc.</td>
</tr>
<tr>
<td>Virginia</td>
<td>September, 1953</td>
<td>N.J. Type</td>
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<td>North Carolina</td>
<td>May and August, 1953–1954</td>
<td>Clinical</td>
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<td>Louisiana</td>
<td>August, 1954</td>
<td>N.J. Type</td>
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In the course of the eradication of vesicular exanthema in swine, vesicular stomatitis was encountered in Georgia in 1952 and 1953; in North Carolina in 1953 and 1954; in Virginia in 1953; in Florida in 1954, and in Louisiana in 1954. A brief history of these outbreaks follows:

**Georgia** (5). Beginning in May 1952 and continuing through May, June, July and August of 1952 and the same period in 1953, repeated outbreaks of vesicular stomatitis occurred in swine in Georgia. Positive diagnoses were made on three premises in 1952 involving over 1,000 head of swine, and on ten premises in 1953 involving approximately 700 swine. These outbreaks have occurred in six counties located in southeast Georgia in an oval-shaped area measuring approximately 140 miles by 50 miles. This area is drained by the Altamaha River and three smaller rivers which form and flow into it and by the Satilla River which has no connection with the Altamaha or its tributaries. Excepting for cultivated land, the country involved is heavily wooded and much of those parts lying adjacent to the creeks and rivers is swampy. Open range conditions prevail so that livestock intermingle regardless
of ownership, and even though there were cattle and mules on eight of the thirteen premises where vesicular stomatitis was diagnosed, it was observed to affect cattle in only one instance.

The occurrence of vesicular stomatitis in swine in Georgia is summarized as follows:

1. It has affected swine and not cattle in all instances but one in the outbreaks occurring in 1952 and 1953.
2. These outbreaks have occurred in the months of May, June, July and August.
3. They have been confined to six counties which were located within an oval-shaped area approximately 140 miles by 50 miles in size which, excepting for cleared land, is heavily wooded and in which the river bottoms in many instances are swampy.
4. Open range circumstances prevail.
5. The New Jersey type of vesicular stomatitis has been shown to be the causative agent in each case where serological tests have been conducted.

However, tests on serum samples from horses and cattle showed that vesicular stomatitis had been present in these areas.

North Carolina. In the first outbreak at Goldsboro, Wayne County, the latter part of May 1953, the disease was identified as vesicular stomatitis of the New Jersey type by animal inoculation and serological tests. The typing was done serologically in the laboratories of the Animal Disease and Parasite Research Branch of the Agricultural Research Service. There were three cattle on the premises in close contact with the swine but the cattle, at the time of examination, were found to be normal. The disease apparently was present only in the pigs. The herd consisted of 2 brood sows, 9 suckling pigs, 1 boar, and 10 feeder shoats that weighed 150 to 175 pounds. The brood sow and 5 of the 9 pigs showed lesions, but none were found in the feeder shoats or the boar.

The second outbreak occurred in a group of 72 swine at Washington, Beaufort County, August 25, 1954. This outbreak was also confirmed by animal inoculation and serological tests as being vesicular stomatitis of the New Jersey type. About 90 per cent of the swine on the farm had lesions of both the feet and the snout. A self-feeder with a metal lid might possibly have accounted for the snout lesions. There were numerous crab shells on the premises which might have produced injuries on the feet and perhaps accounted for extensive foot lesions. A number of cattle and 2 mules on this farm never showed any evidence of the disease, and serological tests on two cattle and two mules from this farm were negative. In both of these outbreaks garbage feeding could not be considered a factor. No animals of any type had been recently added to the herd and the owner did not attend livestock auction sales. The origin of the infection is still listed as “unknown.”

Virginia. The first indication that vesicular stomatitis might actually be occurring in swine in Virginia came to the attention of the State authorities in the fall of 1953 during the severe outbreak of vesicular stomatitis in cattle. During this outbreak vesicular stomatitis was definitely diagnosed by animal inoculation tests in cattle on various farms. In two instances there were cases where lesions were observed in swine on the same farms where vesicular stomatitis occurred in the cat-
It was not possible to obtain material from the swine in either of the cases to run the differential diagnostic test.

In case No. 1 at Elkton, Rockingham County, horses, cattle, and swine were on this farm. One cow became affected about September 13. Milk from the affected cow was fed to fattening pigs on September 17. A vesicular condition appeared on the snout and mouth of some of the swine September 20. At the time of observation no material was available for test purposes.

Case No. 2 at Maurertown, Shenandoah County, was also not diagnosed by animal inoculation. Serum samples were collected from a number of animals on this farm and serological tests at the Animal Disease and Parasite Research Branch laboratories showed that the samples from horses and the cows gave positive reactions to the complement-fixation test, using New Jersey vesicular stomatitis type antigen. Inconclusive results were obtained with the swine samples.

In commenting on the outbreaks in North Carolina and Virginia, Dr. J. B. Healy, Special Diagnostician, Animal Disease Eradication Branch, Agricultural Research Service, Richmond, Virginia, makes the following observation:

"Drought conditions have prevailed in the affected areas and the incidence disappeared shortly after the first hard freeze. In no cases has it been possible to determine that infection has been introduced into an area through the movement of animals. I would certainly think that insects must not be overlooked in considering this problem."

Florida. An outbreak of vesicular stomatitis in swine was reported July 20, 1954 at Ponce de Leon, Holmes County, and diagnosed serologically as the New Jersey type. There were 21 swine involved and they were grain-fed. A second outbreak occurred July 22, 1954 at Ponce de Leon where 37 swine were involved, and these were also grain-fed.

Louisiana. An outbreak of vesicular stomatitis, involving 90 swine, was reported August 10, 1954, at Port Barre, Saint Landry County. The owner fed corn from local mills. No garbage was fed. New Jersey type vesicular stomatitis was determined serologically.

It is significant to note (1) that in none of these cases was garbage fed; (2) that in one of these cases the infection came from infected cattle on the same farm, and (3) that the movement of animals could not be incriminated as the cause of the introduction of the infection.

In the past vesicular stomatitis in swine has not been considered of particular importance except from an experimental point of view since it was only occasionally reported. However, with its definite appearance under natural conditions in several States, it now presents a problem of particular importance. While a definite program for the control and eradication of vesicular exanthema is in effect, and definite programs have to be followed in outbreaks of foot-and-mouth disease, the status of vesicular stomatitis, particularly in swine, with regard to control and eradication measures remains to be determined. The disease in swine needs to be differentiated from vesicular exanthema and foot-and-mouth disease and its appearance in swine also presents a hazard with regard to its possible spread through uncooked garbage and its possible entrance into hog cholera serum plants as occurred in 1943 in
Missouri, with rather disastrous results. From a careful investigation made at the time of the outbreak of vesicular stomatitis in swine in the serum plant in Missouri definite evidence indicated that the hog cholera virus used for hypering pigs was contaminated with the virus of vesicular stomatitis. The following is quoted from the report made on this outbreak:

"No definite source of the virus causing the outbreak was found. . . . It was concluded, however, that there was a slight possibility that one of the virus pigs had an inapparent vesicular stomatitis blood infection at the time it was used for virus production."

It has been shown experimentally that swine are highly susceptible by intravenous inoculation and local scarification to the virus of vesicular stomatitis and that they present lesions indistinguishable from those of foot-and-mouth disease and vesicular exanthema. Evidence has also been accumulated that shows that the disease can spread by contact, the contact animals either showing frank evidence of the disease or develop an inapparent infection indicated by the immunity response of such an animal to a subsequent inoculation of the virus.

In a report on investigations on the pathogenicity of vesicular stomatitis virus Wagener (6) reports as follows:

"Of significance is the fact that wild rats were found to be very susceptible to vesicular stomatitis. . . . Considering the facts that wounds on the feet of wild rats are not unusual, as it was proved in caught rats, and that wild rats could be infected by contact after scarifying the pads, the wild rat should be taken into consideration in vesicular stomatitis control."

Kowalzyk and Brandly (7) have reported on experimental infections of dogs, chinchillas and hamsters with vesicular stomatitis virus.

Little is known concerning the stage of blood infectivity in vesicular stomatitis in swine nor the period during which infected swine are capable of transmitting the disease by contact. Additional research needs to be done on this disease in swine to develop more information, and a detailed epizootiological study should be made in the field in those areas where the disease appears in swine, looking to the source of the infection and its mode of spread under natural conditions. That insects may be involved in the spread of vesicular stomatitis in cattle and in horses has been suggested and limited observations have been made. The disappearance of the disease following frost is significant.

It would appear from the evidence that has accumulated so far over the past two years, that vesicular stomatitis in swine cannot be related to garbage feeding. It would also appear that the disease is found in areas and on premises where other species of livestock may, or may not have been infected, and it would appear that the disease in swine very probably comes from this or some other common source. Whether the disease is further propagated in swine or wild life in areas such as those involved in Georgia, together with the mode of spread, remains to be determined.

The potentiality of the importance of vesicular stomatitis in swine is recognized and is a problem that should receive careful consideration as to how it should be handled. This must await further deliberations and research. In the meantime the
identification of the disease in swine by animal inoculation test should be carried out together with the determination of the type involved. The quarantining of infected premises should be carried out for at least two weeks following the last case of infection on the farm, as is now practiced. The cooking of garbage would eliminate the possibility of the spread of the disease through the feeding of raw garbage, and the program now in effect to have all garbage cooked should minimize the danger from this source of the possible spread of vesicular stomatitis under present conditions.

REFERENCES

EXPERIMENTAL INFECTIONS WITH VESICULAR EXANTHEMA.
PART III. VIREMIA STUDIES IN SWINE AND THEIR RELATIONSHIP TO VESICULATION

W. C. PATTERSON, V.M.D., AND J. R. SONGER, B.A.*

When the virus of vesicular exanthema is inoculated intradermally on the snout of a susceptible pig, the typical reaction is the development of vesicles on the snout in about 24 hours accompanied by a rise in body temperature. These primary vesicles rupture and at about 48 to 72 hours following inoculation, secondary vesicles develop on the coronary bands, interdigital spaces and soles of the feet. Apparently after multiplication in the epithelium which is first invaded, the virus of vesicular exanthema escapes into the blood stream, is carried to all the organs and tissues, and secondary vesicles are formed in the epithelium—distant from the original site of entry.

Following intravenous inoculation of a susceptible pig with vesicular exanthema virus, an increase in the viral concentration of the blood is noted prior to vesiculation of the inoculated pig. The exact site of the virus multiplication in this type of a reaction has not been proved by experimental procedures.

Mott, et al. (1) in 1953 reported that the virus of vesicular exanthema was spread by direct contact from a reacting pig for a period of about 120 hours beginning just prior to the formation of vesicles. These workers also reported that intravenously inoculated swine, slaughtered six hours before vesicles would have developed, were found to have the virus throughout the body. Tissues collected at this time produced lesions when fed to susceptible swine.

The spread of vesicular exanthema virus by direct contact and by the feeding of infective meat scraps, has considerable practical importance when one realizes that both methods of spread might occur prior to the formation of vesicles in a reacting animal. Also, it has been found that a certain percentage of animals develop lesions or an immunity without lesions while failing to show temperature elevations.

Madin and Traum (2) have reported on a series of animals inoculated on the snout with the virus of vesicular exanthema and sacrificed at 24, 48, 72, and 96 hours. Aliquots of blood and spleen from these animals were inoculated into susceptible pigs. The 24- and 48-hour blood and spleen samples were positive. Blood was negative at 72 and 96 hours. This work shows that a viremia is produced in which virus may be recovered from the blood at 24 and 48 hours after intradermal inoculation.

This paper reports the results of a series of viremia studies in which inoculated animals were periodically bled and subinoculations made into susceptible pigs. Also included is an experiment in which inoculated animals were periodically sacrificed and tested for infectivity by feeding their tissues to susceptible swine. These

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experiments have been restricted, since to date the pig is the only reliable research animal for work with the virus of vesicular exanthema.

**MATERIALS AND METHODS**

Procedures used to maintain strict quarantine have been described in a previous paper (1). The virus used in experiments “A” and “D” was type B51, a seventh passage of an original harvest made June 17, 1952, from a field outbreak in Nebraska. Type B51 virus, a second passage from a field outbreak in New Jersey and collected February 11, 1954, was used in experiments “B” and “C”. The usual procedure was to use virus pools in which a large number of pigs were inoculated, the virus harvested, ground in cooled mortars, using sterile ground glass about the coarseness of sea sand as an abrasive. This epithelial paste was diluted with phosphate buffered saline pH 7.6 and 10 mgm./cc. of dihydrostreptomycin sulfate added, the final concentration of the pool being a 20 per cent virus extract. This pool was preserved at -70°C. in a dry ice chest. Prior to use, the virus suspension was centrifuged for ten minutes at 2000 R.P.M. and the supernatant was used as the inoculum.

Virus titrations were made intradermally, from which intravenous doses were calculated. These calculations were based on comparative titrations by different methods reported by Mott, et al. (1), which indicated that viral epithelial suspensions or infected defibrinated blood when inoculated, required 10 to 100 intradermal snout minimum infecting doses (MID) to make one intravenous MID. The actual virus dose varied in the different experiments depending on the intradermal titration of the virus. All intravenously inoculated donor pigs received a calculated 50 intravenous MID.

Test swine averaged 150 lbs. and were temperatured prior to inoculation to establish the normal temperature patterns. During the experiment the animals were temperatured twice a day and observed for the development of lesions. Any febrile reaction of 104°F. and above was considered significant. The animals were observed for three weeks and then challenged to determine if any immunity had developed.

**EXPERIMENTS**

*Experiment “A” (Viral Concentrations in Swine Blood)*

Five donor pigs were inoculated intravenously with five ml. per pig of a 10⁻¹ dilution of vesicular exanthema virus. This dose was calculated to be 50 intravenous MID’s, based on a preliminary intradermal titration of the virus pool. Ten cc. blood samples were collected every 12 hours from each pig using sodium citrate as an anticoagulant. These blood samples were pooled and subinoculations were made into groups of two susceptible pigs. Subinoculations were made intradermally (2 cc. per pig) at 0, 12, 24, 36, 48, 60, 72, 84, 96, 108, and 120 hours, following the inoculation of the donor pigs. Intravenous subinoculations (20 cc. per pig) were made at 24, 48, 72, and 96 hours after inoculation of the donors. All pigs were challenged at three weeks following the last subinoculation.
**Experiment “B” (Viral Concentrations in Swine Blood)**

This experiment was similar to experiment “A,” except that another source of virus was used for the donor pigs. The calculated dose used for these donors was the same as for experiment “A” (50 I.V. MID's). Donors were inoculated with 5 cc. per pig of a $10^{-4}$ virus suspension. In addition, subinoculations made at 0, 12, 24, 36, 48, 60, 72, 84, 96, 108, and 120 hours were made intravenously (20 cc. blood per pig), while those made at 24, 48, 72, and 96 hours were made intradermally (2 cc. blood per pig).

**Experiment “C” (Viral Concentrations in Swine Blood)**

Unlike experiments “A” and “B,” five donor pigs were inoculated on the snouts by scarification, using a ground epithelial paste from recently passaged virus as the inoculum. One pig only was bled periodically, to follow the viremia of an individual pig, the others observed for reactions. The donor pig was bled at 0, 12, 24, 36, 48, 60, 72, 84, 96, 120, and 144 hours following inoculation. Subinoculations were made into groups of two susceptible pigs. Twenty cc. doses were inoculated intravenously into each pig.

**Experiment “D” (Viral Concentration in Swine Tissues Measured by Feeding)**

Twelve donor pigs were inoculated intravenously with 5 cc. per pig of 1:20 virus suspension and observed for reactions. Two donor pigs were sacrificed at 1, 2, 5, 7, 14, and 30 days after inoculation. Parts of the carcasses of each pair of donor pigs were pooled and contained foot and snout tissues, meat, lymph glands, heart, lung, spleen, liver, kidney, blood, and crushed bone. Approximately 50 lbs. of meat scraps from each pool were fed to groups of five susceptible pigs which had been fasted for 48 hours prior to feeding. The meat scraps were allowed to remain in the pens for 24 hours after feeding. All negative pigs were held and challenged at three weeks.

**EXPERIMENTAL RESULTS**

**Experiment “A” (Viral Concentrations in Swine Blood)**

Following intravenous inoculation with 5 cc. of a $10^{-1}$ vesicular exanthema virus suspension, the first donor pig to show a temperature elevation was at 24 hours, while the first lesion to be observed was at 60 hours.

The results of subinoculations are recorded on Table I. Those pigs inoculated with blood collected immediately following inoculations of the donors were negative. At 12 hours one pig was negative, the other was immune to challenge although no lesions were observed. At 24 hours both pigs subinoculated intradermally were immune while failing to develop lesions and those subinoculated intravenously with the same sample showed lesions. At 36 hours one intradermally exposed pig was immune without lesions, and the other developed lesions. At 48 hours one out of one on the intradermal group had lesions. In the intravenous group one pig remained negative, the other developed immunity without lesions. Both intradermal pigs were negative at 60 hours. At 72 hours both intravenous pigs had lesions, the intradermal group had one pig with lesions, and one became immune while failing to show lesions. At 84 hours one pig was negative and one was immune to challenge. The
TABLE I

Results of Subinoculations of Blood from Five Donor Pigs Intravenously Exposed with Type “B51” Vesicular Exanthema Virus (First Temperature Elevation of Donors at 24 Hours and the First Lesion at 60 Hours)

<table>
<thead>
<tr>
<th>Group</th>
<th>Hours Following I.V. Inoc. of Donor Pigs</th>
<th>Intradermal Subinoculations</th>
<th>Intravenous Subinoculations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Initial reaction</td>
<td>Challenge</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0/2</td>
<td>2/2</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
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<td>0/2</td>
</tr>
<tr>
<td>4</td>
<td>36</td>
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</tr>
<tr>
<td>5</td>
<td>48</td>
<td>1/1†</td>
<td>-</td>
</tr>
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<td>6</td>
<td>60*</td>
<td>0/2</td>
<td>2/2</td>
</tr>
<tr>
<td>7</td>
<td>72</td>
<td>1/2</td>
<td>0/1</td>
</tr>
<tr>
<td>8</td>
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<tr>
<td>11</td>
<td>120</td>
<td>0/2</td>
<td>2/2</td>
</tr>
</tbody>
</table>

Numerator indicates number of positive pigs, denominator indicates number of pigs in groups.
Dash indicates no challenge was made since all pigs had developed lesions and were known immunes.
All challenges made at three weeks.
* First donor positive at 60 hours.
† One pig died in this group.

96-, 108-, and 120-hour groups were all negative. Virus was first detected in the 12-hour intradermal group and the last reaction was in the 84-hour intradermal group.

Experiment “B” (Viral Concentrations in Swine Blood)

Five donor pigs inoculated intravenously with 5 cc. of a $10^{-4}$ dilution of virus had temperature elevations at 60 hours and the first lesions were observed at 72 hours. The results of subinoculations are recorded in Table II. Those pigs inoculated with blood samples collected at 0 and 12 hours were negative. At 24 hours both intradermally exposed pigs were negative while one intravenous pig was negative and one developed lesions. The 36-hour group had both pigs showing lesions. At 48 hours both intradermally exposed pigs were negative while both intravenously exposed animals developed lesions. The 60-hour group was negative. In the 72-hour intradermal group one pig developed lesions, the other failed to show lesions but was immune to challenge. In the intravenously exposed pigs one animal was negative, the other immune to challenge. Both pigs in the 84-hour group were negative. At 96 hours the intravenously exposed pigs were negative, while one intradermal animal developed lesions and the other was immune while failing to show lesions. The 108- and 120-hour groups were negative. Virus was first detected on subinoculation in the 24-hour intravenous group and the last reaction was in the 96-hour intradermal group.
TABLE II
Results of Subinoculations of Blood from Five Donor Pigs Intravenously Exposed with Type "B61" Vesicular Exanthema Virus (First Temperature Elevation of Donors at 60 Hours and the First Lesion at 72 Hours)

<table>
<thead>
<tr>
<th>Group</th>
<th>Hours Following I.V. Inoc. of Donor Pigs</th>
<th>Intradermal Subinoculations</th>
<th>Intravenous Subinoculations</th>
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<tbody>
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<td></td>
<td></td>
<td>Initial reaction</td>
<td>Challenge</td>
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<tr>
<td>1</td>
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<tr>
<td>11</td>
<td>120</td>
<td>1/2</td>
<td>0/1</td>
</tr>
</tbody>
</table>

Numerator indicates number of positive pigs, denominator indicates number of pigs in groups.
Dash indicates no challenge was made since all pigs had developed lesions and were known immune.
All challenges made at three weeks.
* First donor positive at 72 hours.

Experiment "C" (Viral Concentrations in Swine Blood)

In this experiment only one donor pig was bled. This animal, inoculated by scarification on the snout, showed a temperature elevation and snout lesions at 24 hours and generalization to the feet at 60 hours.

On subinoculation only two groups reacted. In the "48-hour" group both pigs developed lesions, while the "72-hour" group had one pig develop lesions and the other was immune when challenged. Pigs inoculated at 0, 12, 24, 36, 60, 84, 96, 120, and 144 hours failed to develop either lesions or immunity.

Experiment "D" (Viral Concentration in Swine Tissues Measured by Feeding)

Twelve pigs were inoculated intravenously with vesicular exanthema virus and all twelve developed temperature elevations. Ten of the inoculated animals developed lesions—two of the original twelve being destroyed at 24 hours—prior to vesiculation. Lesions were found on at least three of the feet of all positive pigs.

The reactions of those pigs fed meat scraps are shown on Table III. In the first group of five susceptibles fed meat scraps from two donor pigs slaughtered 24 hours after intravenous inoculation and fed within one hour after slaughter, five pigs were positive—four positive four days after feeding and one at seven days (Table IV). In the group fed meat scraps from those destroyed 48 hours after inoculation, three were positive—one at four days, one at five days, and one at seven days after feeding. On challenge, both negative pigs were found to be immune. Those fed meat scraps
TABLE III

Results of Feeding of Meat Scraps from Donor Pigs Intravenously Exposed with Type "B51" Vesicular Exanthema Virus (First Temperature Elevations of Donors at 24 Hours and the First Lesions at 48 Hours)

<table>
<thead>
<tr>
<th>Group</th>
<th>Feeding Time (Hours Following I.V. Inoc.)</th>
<th>Initial Reactions</th>
<th>Challenge</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>24 hours</td>
<td>5/5</td>
<td>—</td>
</tr>
<tr>
<td>2</td>
<td>48 hours</td>
<td>3/5</td>
<td>0/2</td>
</tr>
<tr>
<td>3</td>
<td>5 days</td>
<td>3/5</td>
<td>0/2</td>
</tr>
<tr>
<td>4</td>
<td>7 days</td>
<td>0/5</td>
<td>4/5</td>
</tr>
<tr>
<td>5</td>
<td>14 days</td>
<td>0/5</td>
<td>5/5</td>
</tr>
<tr>
<td>6</td>
<td>1 month</td>
<td>0/5</td>
<td>5/5</td>
</tr>
<tr>
<td>7</td>
<td>Controls</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Numerator indicates number of positive pigs, denominator indicates number of pigs in groups.
Dash indicates no challenge was made since all pigs had developed lesions and were known immune.
All challenges made at three weeks.

TABLE IV

Incubation Periods of All Pigs Which Developed Lesions When Fed Meat Scraps from Donor Pigs Intravenously Exposed with Type "B51" Vesicular Exanthema Virus

<table>
<thead>
<tr>
<th>Group</th>
<th>Feeding Time (Hours Following I.V. Inoc.)</th>
<th>Incubation Periods of Positive Animals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>4 days 5 days 6 days 7 days 8 days 9 days 10 days 11 days</td>
</tr>
<tr>
<td>1</td>
<td>24 hour</td>
<td>4* 1 1 1 1 1 1</td>
</tr>
<tr>
<td>2</td>
<td>48 hour</td>
<td>1 1 1 1 1 1</td>
</tr>
<tr>
<td>3</td>
<td>5 day</td>
<td>1 1 1 1 1</td>
</tr>
</tbody>
</table>

* Indicates number of positive animals.

at five days had three pigs showing lesions—one at 7 days, one at 8 days, and one at 11 days. On challenge, both negative pigs were found to be immune. All pigs in the 7-day, 14-day, and one-month groups were negative for vesicles or clinical lesions. On challenge, one of five negative pigs in the 7-day group was negative, indicating the presence of virus which produced an inapparent infection followed by the development of immunity. All pigs in the 14-day and one-month groups were positive on challenge, demonstrating the susceptibility of the test pigs and the absence of virus in the tissues of the donor swine.

DISCUSSION

In experiments "A" and "B" where intravenous inoculations of donor pigs were made, the dose of inoculum was purposely calculated to be small enough that negative blood samples could be collected and any subsequent positive bleedings would
indicate virus multiplication in the donor animals. As seen in experiment "A," the sample collected immediately following inoculation (from a site distant to the site of inoculation) was negative. However, twelve hours later virus multiplication had increased so that immunity was produced in one of the two subinoculated swine. Again, in experiment "B" the 0- and 12-hour groups were both negative while the 24-hour group had one positive pig.

While the size of doses varied in experiments "A" and "B" the period of blood infectivity (72 hours) remained the same. A decrease in the size of the dose (5 cc. of a 10^{-1} virus suspension in experiment "A" and 5 cc. of a 10^{-4} virus suspension in experiment "B") lengthened the period between inoculation and temperature elevation (24 hours in experiment "A" and 60 hours in experiment "B") and the period between inoculation and vesiculation (60 hours in experiment "A" and 72 hours in experiment "B"). However, the relationship of blood infectivity to time of vesiculation of donors was the same in both experiments.

It was difficult to demonstrate the increase in the concentration of virus in the blood of donors by the severity of the reactions, the incubation periods, and the temperature reactions of subinoculated test animals. This was due in part in experiments "A" and "B" to the fact that blood was pooled from five donor pigs each of which had a slightly different period of infectivity following intravenous inoculation.

The exact site or sites of virus multiplication following an intravenous inoculation remains unproven. It would appear that after an intravenous inoculation the virus is carried to the epithelial tissues, particularly the feet, where multiplication is initiated within the epithelial cells. Virus is then discharged into the blood stream and is detected by subinoculations of blood. This does not eliminate the possibility of multiplication elsewhere, since virus has been demonstrated in the blood as early as 48 hours before vesiculation of the feet in intravenously inoculated pigs, and not until 12 hours before vesiculation of the feet when the donor was inoculated by scarification of the snout. Previous experimentation (1) has shown that meat scraps fed from reacting pigs slaughtered six hours before vesicles would have developed were found to have a higher concentration of virus in the feet and snout than in the blood, spleen, or bone marrow. This would indicate that virus was being formed in the epithelial tissues and then discharged into the blood stream.

As in previous work, a good percentage of animals developed immunity while failing to present any clinical reactions. In experiment "A" four of the pigs developing lesions and two of those with immunity without lesions had significant temperature elevations. Three with lesions and five developing immunity without lesions failed to show significant temperature rises. Thus, in experiment "A" 43.8 per cent of the reacting pigs had significant temperature rises, while 56.2 per cent of those reacting failed to show a temperature rise. In experiment "B" all seven of the animals which developed lesions after subinoculation had significant temperature rises and none of the three animals which were immune without evidence of lesions had temperature rises.

In experiment "C" where one intradermally exposed donor was bled periodically, reactions were observed only in the 48-hour and 72-hour groups. Blood collected at 0, 12, 24, and 36 hours was negative, although primary vesicles were observed on the snout of the donor at 24 hours. The 48-hour sample was positive with the donor
pig showing generalization lesions on the feet at 60 hours. The lesions of the donor pig were as severe as any reaction observed in our experimental work, indicating that based on the clinical reaction of this pig the viral content of the donor's blood should have been quite high. In all probability there was virus in the blood between the 24- and 48-hour periods, but since subinoculation doses were only 20 cc. intravenously the concentration of virus was probably not sufficient to produce reactions. The difference in the disease course and viremia between donor pigs intradermally exposed and those intravenously exposed suggests a different pattern of virus multiplication for the various methods of exposure. Additional work is needed to confirm this observation.

The size of a dose of blood from a reacting pig has much to do with the results obtained in those animals inoculated. Two cc. intradermal and 20 cc. intravenous were selected as the doses, since both of these doses of infective blood had produced reactions in previous work and also this dose constituted a safe amount to be bled from the donor pig every 12 hours (50 cc.). In all probability a greater number of pigs might have reacted had the subinoculations been of a greater dosage.

Meat scraps from intravenously inoculated swine were infective for seven days following inoculation. While none of those pigs fed meat scraps at seven days developed lesions, one susceptible did develop an immunity without lesions. In relationship with vesiculation, meat scraps from donors were infective for about 120 hours post vesiculation.

Figure 1 demonstrates the relationship of viremia with virus elimination by direct contact and the feeding of infective meat scraps when the donor pigs have been
inoculated intravenously. The comparison is made on the basis of the time of vesicu-
lation in the donors.

When blood was collected and subinoculated into susceptibles, the virus was first
demonstrated 48 hours prior to vesiculation and was present for 36 hours after
vesiculation. The period of spread by direct contact begins about 12 hours prior to
vesiculation and continues for about 108 hours after vesiculation. Thus, it can be
seen that spread from direct contact extends for a much longer period than the
viremia due to the fact that the vesicles harbor and discharge active virus for about
72 hours after the virus has disappeared from the blood.

The period of spread by feeding meat scraps includes both the period of viremia
and that in which vesicles are capable of spreading virus. Meat first becomes infec-
tive when the blood contains a virus concentration capable of infecting susceptibles
and continues past the blood infecting period and includes the period of spread from
vesicles. In this feeding experiment the period of spread by feeding began 24 hours
prior to vesiculation of the donors and continued for 120 hours after vesiculation of
the donors.

**SUMMARY**

1. The viremia period of intravenously exposed swine is 72 to 84 hours, beginning
   about 48 hours prior to vesiculation in the donor pigs and ending 36 hours after
   vesiculation.

2. Virus elimination by direct contact for the most part follows the period
   of viremia beginning just prior to vesiculation in the donor pigs and continuing for
   about 108 hours. This is due to the fact that virus is eliminated from the vesicles
   which harbor virus for about 72 hours after the virus has disappeared from the blood
   stream of donor pigs.

3. An alteration in dosage of intravenously exposed donors altered the time of
   vesiculation in these donors, but had no effect on the period of viremia.

4. There appears to be a marked difference in the pattern of viremia in intr
   dermally exposed as compared with intravenously exposed swine. Additional wor:
   is needed to confirm this observation.

5. Meat scraps from infected pigs slaughtered up to and including seven days
   after intravenous inoculation produced lesions or immunity when fed to susceptible
   pigs. The donor pigs showed lesions at 48 hours and their meat was infective for
   about 120 hours after vesiculation.

6. Meat scraps from 14-day and one-month convalescent vesicular exanthema
   swine failed to infect susceptible test pigs by feeding.

**Acknowledgments.** The writers are pleased to acknowledge the valuable advice of
Dr. L. O. Mott of the Animal Disease and Parasite Research Branch in connection
with the studies here reported.

Acknowledgment is made also to Dr. E. W. Jenney and Mr. S. R. Hopkins for the
technical assistance given in carrying out certain phases of this work.

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VESICULAR EXANTHEMA. III


REPORT OF THE COMMITTEE ON VESICULAR DISEASES


By the term vesicular diseases of livestock in the country we refer to Foot and Mouth Disease, Vesicular Exanthema and Vesicular Stomatitis. There are times when one disease can directly or indirectly be just as damaging to the livestock producer as the other. These diseases do present a challenge to us and we should be prepared to meet them.

As times change, the viewpoint of those responsible for the control and eradication of animal diseases should also change. Years ago a disease in one State was not considered a threat to other States. As a result of this thinking, a costly lesson has been learned in the recent experience with vesicular exanthema. Faster means of transportation has literally "shrunk the world." The incidence of infection in another country may be their problem today but ours tomorrow. Whenever a disease appears for the first time in a State, suspicion is immediately cast upon the State or country in which the disease is known to have existed. Therefore, this Committee believes it is important to be kept abreast of the disease situation in other countries as well as in our own.

There is always a possibility that diseases may cross certain barriers, regardless of precautions taken. Even when the infection is relatively small in other countries, it may spread from them to us. Theoretically speaking, when the incidence of infection increases in these other countries, the possibility of spreading the disease to us likewise increases. You may recall that Canada experienced its outbreak of foot-and-mouth disease when the disease was raging in Western Europe.

During the past year the Pan American Foot-and-Mouth Disease Center at Rio de Janeiro, Brazil, has compiled reports of the various countries in the Americas and intends to report annually on the incidence of vesicular diseases. Likewise, the International Office of Epizootics is reporting on these and other diseases, that exist in the major countries of Europe, Asia and Africa, on a monthly basis. The reports are not complete, but at least it is a start towards a plan that can give us more authentic information in the future.

INCIDENCE OF FOOT-AND-MOUTH DISEASE

Fortunately, another year has passed without foot-and-mouth disease appearing in this country.

Foot-and-mouth disease was not reported in Canada during the past year. Thirty months has now passed since the last known infected animals were disposed of in that country.

A great deal of progress was made in Mexico during the past year relating to their foot-and-mouth disease eradication program. The eradication phase of their
program has been considered completed and a program of extensive inspection and observation is now being carried out. On April 14 the Secretary of Agriculture announced that, if present favorable conditions with respect to foot-and-mouth disease in Mexico continue, and no more outbreaks occur, he will declare Mexico to be free of the disease as of December 31, 1954. On that date the United States-Mexican border will automatically be opened to imports of livestock and livestock products.

The report by the Pan American Foot-and-Mouth Disease Center in Brazil lists this disease as appearing in Argentina, Bolivia, Brazil, Chile, Colombia, Martinique, Paraguay, Uruguay and Venezuela during 1953. They have not reported on the incidence during 1954 but information has been received that the disease has been found in Peru, the Island of Martinique and the Aruba area owned by the Netherlands (off the coast of Venezuela) where it was not reported in 1953. It is hoped that steps can be taken so that eventually we may be fully informed on the incidence of this disease in the Americas on a monthly basis.

During the past year the incidence of foot-and-mouth disease in Europe, Asia and Africa was very low as compared with the early 1950's.* For example: during 1952, France reported 320,016 outbreaks, and during 1953—5,513. During 1952, Western Germany reported 54,572 outbreaks, as compared with 2,012 during 1953. The incidence of infection as reported during 1954 still shows a marked decrease and for the first eight months the countries having the most infection were Italy with 800, Belgium with approximately 500 outbreaks and West Germany with approximately 200 outbreaks. The infection appeared in the other countries but was not very widespread.

Compared to previous years, foot-and-mouth disease thus far this year has not run its usual spectacular course in any country in the Americas, or in those countries in Europe that report on the incidence of the disease.

Perhaps it may be advisable to bring your attention to Great Britain's "Report of the Departmental Committee on Foot-and-Mouth Disease—1952–1954". A committee was selected to review the policy and arrangements for dealing with foot-and-mouth disease in Great Britain and to advise whether any changes should be made in the light of present scientific knowledge and the technical and administrative experience gained in this and other countries.

The Committee secured information in writing from several countries and visited France, Switzerland, Belgium, Holland, Denmark, Norway, Sweden, Brazil and Argentina. Excerpt from the committee reports is as follows:

"We wish to make it clear at the outset that we are not among those who regard stamping-out with complacency. We sympathize with the widely expressed view that it is a crude and primitive way of dealing with a disease. We know what a harrowing duty it is for the officers of the Ministry who have to carry it out. We recognize the mental anguish it may cause to those who suffer its consequences and the shattering disaster, not computable in terms of money, that it may bring to a farmer who has to see the work of a lifetime destroyed in a day. Nevertheless, we have no doubt whatever that in the present circumstances it must continue.

* International Office of Epizootics.
"For reasons we have already explained, we are convinced that it is impossible
to exaggerate the importance of taking instant action to prevent the propagation
of the virus. Both at home and abroad we found our witnesses unanimous that the
only sure way of doing this is to slaughter the animal; the evidence we have quoted
shows that most countries—perhaps all—would have recourse to this method if
the incidence of the disease could be reduced to a point low enough to make it
practicable. If we take as our postulate—as we think we are bound to do—that once
an animal gets the disease there is no other safe course, it follows that stamping-out
could only be completely discontinued in this country if all susceptible animals in
it were made permanently immune. The only promising way of doing this that
science has discovered is repeated vaccination. Since the immunity it gives cannot
be relied on to be completely effective for more than four months, this would mean
the vaccination of some ten million cattle, twenty-two million sheep and four million
pigs three times a year.

"We know how dangerous it is to be dogmatic about the limitations of possible
scientific discovery. We recognize that there may be advances that would make the
picture quite different. But if we look at the circumstances of today, and of the
immediate future so far as they are foreseeable, we must conclude that any idea
that it would be possible to do away with stamping-out by making the whole sus-
ceptible animal population—or even all cattle—immune by vaccination is in the
realm of fantasy. Nor, indeed, did any witness suggest that it could be done. But
as there seems to be much popular interest in this subject, and some common mis-
conception, we have thought it worthwhile to examine the implications of such an
undertaking."

The report then explains the comparison between costs of vaccination as com-
pared with cost of slaughter and the results are that it is far more practical and
economical to follow the stamping-out method. Really, it is the only way known
that has completely eradicated the disease.

One thing must be borne in mind—if this disease ever appears here again,—it
must be found and eradicated before it has a chance to become established. If we
do not wish it to plague our livestock industry, and upset all of our other disease
control programs, we must constantly be on the alert. Every country in the world
that has this disease envies our present position. No group in this country carries
more responsibility to see that this disease does not gain a foothold than this United
States Livestock Sanitary Association.

VESICULAR STOMATITIS

This is considered by some to be the insignificant member of the vesicular dis-
ese family. However, there have been some interesting comments made regarding
this disease that should be mentioned again.

Last year's Vesicular Diseases Committee report states "From the standpoint of
diagnosis, especially, the foot-and-mouth disease problem is inseparable from the
other viral vesicular disease problems—vesicular stomatitis (V.S.) and vesicular
exanthema (V.E.). Moreover, the latter are capable of causing infections in indi-
vidual herds of susceptible animals that are at times as seriously damaging as
foot-and-mouth disease."

In a report made by the Pan American Foot-and-Mouth Disease Center, it was
stated "although not generally as infectious as foot-and-mouth disease, where vesicular stomatitis has occurred, it has often been as severe and occasionally more severe in individual herds than outbreaks of foot-and-mouth disease."

Many reports have belittled the severity of this disease, and even though in the majority of cases it is rather mild, it is not a rarity to see this disease deal a devastating blow to livestock producers. There isn't any reason to believe that this disease couldn't cause as much havoc in marketing channels as vesicular exanthema did. In fact, it may be worse as not only swine but cattle and horses are also naturally susceptible.

For a time it was considered that vesicular stomatitis did not appear in swine from natural infection. This impression has changed since it was reported in swine in Missouri in 1943 and in Georgia, Virginia and North Carolina in 1953. This year it has been reported in swine in Georgia, North Carolina, Florida and Louisiana. A special report on this phase of vesicular stomatitis has just been given by Dr. H. W. Schoening.

How much vesicular stomatitis existed in the United States during the past year is unknown. We do know that more existed than was reported, because in some cases animals used for differentiation of vesicular diseases proved to be immune to vesicular stomatitis. The reports of the disease have been fairly few during the past year. The Committee recommends that the members of this Association give special attention to the incidence of this disease during the coming year. The evidence of having immune animals to this disease, that were not reported to have been infected, is alarming. Oftentimes cases are seen when the lesions are old and it has not been determined which vesicular condition was present. In some areas in this country there has been complacency on the part of some concerning the importance of vesicular stomatitis which is dangerous. Conditions could arise under such a state where foot-and-mouth disease would be overlooked until it involved a large number of premises.

Canada reports that the first incidence of vesicular stomatitis brought to their attention was during the winter of 1938 when a mild epidemic occurred chiefly among horses in the western provinces. A few hundred horses appeared to have been involved; also, a very small number of cattle and a few swine. According to the Canadian authorities, even though they have investigated every reported suspicious vesicular condition, the disease has not been diagnosed since that year.

The disease has been reported in most of the Latin American countries in the past.* During 1953 it was found in Costa Rica, Mexico, British Honduras, Colombia, Ecuador, Guatemala, Paraguay, Peru and Venezuela. Reports on the status of this disease in Latin America during 1954 have not been received.

The disease had been found in Europe but no recent reports of it have come to our attention.

VESICULAR EXANTHEMA

In a paper on this disease given last year to this association by the Chairman of this Committee several conclusions were presented. It may be well to consider them now.

* This information furnished by the Pan American Foot-and-Mouth Disease Center, Rio de Janeiro, Brazil.
1. "Vesicular exanthema is still a threat to the livestock industry of the United States." This is still true but all will agree that the threat is not nearly as strong as it was a year ago.

2. "There is still a possibility that the disease may sweep across the country again unless measures are taken to prevent it." This is also still true but during the past year, with the exception of the East Coast area and California, the disease has been confined to the premises on which it was found.

3. "A chief weakness is that only 31 per cent of 14,000 premises are feeding cooked garbage to swine." The report for the month of September 1954 shows that on 83 per cent of 12,500 garbage-feeding premises, swine are being fed cooked garbage. Last year's report stated "37 per cent of the 14,000 premises are being inspected semi-monthly" and the report for September 1954, excluding Texas since their report was incomplete, reveals an average of 89 per cent semi-monthly inspection of the 12,500 premises.

Point 4 elaborated on the importance of semi-monthly inspection as to (A) finding infection early; (B) as educational means of convincing feeders; (C) helping feeders; (D) checking cooking installations; (E) placing emphasis on sanitation. What is the present picture comparing these points? (A) Infection has been found on individual premises and the infection confined to those premises. (B) The educational approach to the feeders has been largely responsible for the cooperation received from them. (C) Feeders have certainly been helped a great deal in their garbage-cooking problems. (D) Garbage is being cooked better and this is largely due to the time and effort on the part of State and Federal personnel to see that this was done. (E) In most States the sanitary conditions have improved on these types of premises. Some States are rating the premises similar to ratings used by the Boards of Health for public restaurants.

5. "Limit movement of raw-garbage-fed swine." This has certainly been done in most States and was one of the key factors used by the State of California to produce the favorable results they have now achieved regarding the control and eradication of this disease.

6. "Require the cleaning and disinfecting of conveyances and facilities used by swine." This may be one of the important factors in limiting this disease to isolated premises in the hog-belt area during the past year.

7. Certain basic principles were asked to be set up to have uniform programs in the control and eradication of vesicular exanthema in each State. In most States these basic principles can be found in their current programs.

Perhaps a glance at the following slides may emphasize what has been done during the past year and what remains to be done in the coming year to make this eradication program successful.

It can be stressed that the reports on the incidence of vesicular exanthema are probably more accurate than they were a year ago. This is certainly encouraging as even with more frequent inspections in most of the States, the incidence of infection is gradually decreasing.

The coming year could be one of the most important years in this campaign. If the improvement continues as it has during the past twelve months, we should be in a more favorable position towards the eventual eradication of the disease.
VESICULAR DISEASES

There is still a great deal to be done. Let us cherish what we have accomplished, but not become complacent with results to date but become more determined to bring the program to a successful conclusion.

Our goals for the next twelve months should be:
1. Don’t stop looking for new garbage feeders.
2. Concentrate on the remaining raw garbage feeders.
3. Keep a close watch on concentration points for evidence of the disease.
4. Keep up the semi-monthly inspection.
5. Stress cleaning and disinfecting of vehicles that haul swine.
6. Stress education to convince feeders on the need to cook.
7. Get large feeders in Massachusetts to discontinue feeding raw garbage.
8. Acquire a garbage-cooking program in New Jersey.
9. Have laws or regulations passed in North Dakota, Connecticut, New Jersey, California, Vermont and New Mexico.
10. Develop a stronger program in Texas.

This is not the time to relax. The job ahead may be even more difficult than it had been in the past because conditions are not as acute as they were. It will require your wholehearted cooperation.

RECENT RESEARCH DEVELOPMENTS ON VESICULAR DISEASES

Newer approaches and techniques in studying various phases of virus diseases have added a great deal in our knowledge of vesicular diseases.

In foot-and-mouth disease, Gillespie reports the successful regular transmission and propagation of foot-and-mouth disease virus in day old chicks and from there to one week old birds. In this newly discovered susceptible host, there is produced gross lesions packed with high titer virus that is present in the muscles of the gizzard. After 20 passages in day old chicks, the virus no longer is capable of producing lesions in guinea pigs. The effects on large animals have not been reported.

Brooksby and Wardle reported on a sort of a spot plate method of diagnosis and method of titration of foot-and-mouth disease virus and this procedure incorporates the complement fixation technique and the Frenkel method of culture virus on tongue epithelium.

VESICULAR STOMATITIS

From the Plum Island Animal Disease Laboratory, Drs. Bachrach, Callis and Hess will soon report on “The Growth and Cytopathogenicity of vesicular stomatitis virus in tissue culture.”

In a paper now gone to press Ferris, Hanson, Dicke and Roberts of the University of Wisconsin report the important observation of the mechanical transmission of the New Jersey strain of vesicular stomatitis by biting insects under laboratory conditions. Several specie of mosquitoes and horseflies carried the virus for one to three days. In one trial in cattle an infection was produced by a single horsefly.

In vesicular exanthema your attention is called to reports made by Bankowski of California and Brooksby of England. There have been reported in the present and the past at least five immunological and serological types of vesicular exan-
thema virus. Also there is an important report on the "In vitro cultivation and Cytopathogenicity of vesicular exanthema virus by McClain, Madin and Andriese."

The committee regrets that time does not permit its somewhat lengthy comments on the application of the new knowledge contained in its original draft. However, the committee can't refrain from directing your attention to the far reaching aid, the successful tissue culture and cytopathogenicity of the vesicular stomatitis and vesicular exanthema viruses will be in the study and diagnosis of these diseases.

Especially this is true in vesicular exanthema, since in this disease, as you know, we have been greatly handicapped in our studies and diagnosis. We have had to depend almost entirely on the hog for a dependable supply of virus as well as for our studies on the viability of the virus.

Also the successful propagation of the vesicular exanthema and vesicular stomatitis virus on growing cells and the visible pathogenic effect on these cells, will no doubt lead to similar work on the foot-and-mouth disease virus.

CONCLUSIONS

1. Be on the alert for any suspicious vesicular condition.
2. Incidence of diseases, whether they be in another State or in another country, is of importance to us.
3. The presence of foot-and-mouth disease during the current year in other countries has not been as great as it was in the previous three years.
4. A committee appointed by the Minister of Agriculture and Fisheries of Great Britain recommends that there is not any alternative for combatting foot-and-mouth disease than the stamping-out (slaughter method) where it is economically possible.
5. Do not take chances with a vesicular condition.
6. Do not let a vesicular condition go undiagnosed.
7. One oversight could be responsible for foot-and-mouth disease gaining a foothold in this country.
8. There is evidently more vesicular stomatitis in the country than what is being recognized. Let's find out how much vesicular stomatitis we have during the coming year.
9. A great deal of progress has been made in the control and eradication of vesicular exanthema.
10. There is still a great deal to be done in the eradication of this disease. It will require the cooperation of all regulatory officials, as well as the entire swine industry, if the program is to be brought to a successful conclusion.
11. New types of vesicular exanthema virus were found during the year. This makes the need for eradication even greater, since the possibilities of developing an effective vaccine for all types would be extremely difficult.
12. Work has begun on vesicular diseases at Plum Island. This long awaited, needed laboratory has been one of our missing links in our chain of defense to protect the livestock industry.

Dr. Mulhern: From your questions since I arrived here, I think most of you would be interested in seeing a few slides showing more or less what has been done and what we still have left to do in the coming year.
Monthly Incidence of Vesicular Exanthema

[Slide] This chart shows the incidence of infection from June 1952. You will notice that in August 1952 we had the first peak. We had a second peak in February 1953, and since that time the minor peaks shown on the slide as we come up to the present time are merely due to large feeders in the raw garbage feeding areas. In other words, it does not mean there has been an enormous amount of herds. It has usually been a limited amount of herds, but the herds became very large.

Counties Where Vesicular Exanthema Has Been Reported
[Slide] This is a map that you have all seen at one time or another. It shows the counties in which the disease has been diagnosed since June 1952.

Counties in Which Vesicular Exanthema is Now Known to Exist

[Slide] Now we see a comparison, showing in what counties the disease is known to exist today, or perhaps counties in which raw garbage is being fed.

Garbage Feeding Premises and Premises Where Cooked Garbage is Fed

[Slide] This slide will give you a pretty good picture of where we are today. The
dark columns are those garbage feeding premises, and the light columns show those premises on which the swine are being fed cooked garbage. You can see from this chart we are nearing our goal as to the number of premises that are cooking.

Comparison of the Number of Swine Fed Garbage with Those Fed Cooked Garbage

[Slide] This chart shows the number of swine that are being fed cooked garbage. You will notice that there is a decided difference in the percentage of swine as compared with the percentage of premises. This is an indication that we have large feeders who are still feeding raw garbage. These feeders are located chiefly in New Jersey, Massachusetts, California and Texas.

[Slide] We took the three States of California, New Jersey and Massachusetts, the garbage feeding states. The first bar shows the number of swine being fed garbage in those states. The line immediately below it shows the number of swine in the state that are being fed cooked garbage. I wish you would note that this is as of September 1, 1954. I would like to make a contrast with this picture as compared with what it is now. I want to draw your attention to the situation in California.

**Comparison between Garbage Fed Swine and the Number Fed Cooked Garbage in the Three Largest Garbage Feeding States As of November 1, 1954.**

[Graph showing comparison between garbage fed and cooked garbage fed swine in California, New Jersey, and Massachusetts as of November 1, 1954.]

[Slide] Here you can see the progress that has been made in California in relation to the number of swine being fed cooked garbage. The dark line shows the swine being fed cooked garbage, and the light shows the swine fed garbage.

**States Where Vesicular Exanthema Has Appeared Since December 1, 1953.** Isolated Outbreaks in Michigan, Illinois, Iowa, Arkansas and Louisiana.
[Slide] I put this in as food for thought. This map shows the states in which the infection has been found since December 1, 1953. The disease appeared in Michigan, Iowa, Illinois and Louisiana and Arkansas. We have attempted to locate the source of the infection, and we have never done it. There are several theories.

There is a possibility that we have contaminated concentration points that may have been contaminated some time ago when the infection was so widespread. It may be that we should make every effort to get these concentration points cleaned and disinfected. In the meantime we feel sure that time is playing an important factor in helping us disinfect such premises.

Perhaps there are raw garbage feeders that have not been located that are moving infected swine into our markets. We have not actually found the source of this infection.
NOMINATION AND ELECTION OF OFFICERS FOR 1955

The next order of business is the report of the Nominating Committee. Dr. R. W. Smith.

DR. R. W. SMITH: Mr. President and Members of the Association:

Before I announce the results of the canvass by your Nominating Committee, may I state that the Executive Committee heard a letter read to it last night from Dr. I. G. Howe. Dr. Howe has been in ill health for the last two or three years, and in his letter he stated that he was retiring on October 1 and was returning to his former home. He does not intend to enter into practice, but he will spend some time taking care of a little farm that he owns.

I hardly believe he will spend too much time doing that. He indicated in his letter, however, that if he improved in health that was what he would do. He made it definite that he did not wish to be promoted in any way in this organization, although his heart is with us, and if he gets better some day he will come to our meetings.

The Nominating Committee has received suggestions during the week. We wish to present the following names for officers:

President—Dr. H. F. Wilkins, Montana
First Vice President—Dr. A. L. Brueckner, Maryland
Second Vice President—Dr. G. H. Good, Wyoming
Third Vice President—Dr. J. G. Milligan, Alabama

PRESIDENT T. C. GREEN: Gentlemen, are there any nominations from the floor?

DR. R. W. SMITH: If there are no further nominations, I move that nominations be closed and that the Secretary cast the unanimous ballot of the Association for this entire slate.

DR. R. L. WEST: Second the motion.

[The motion was put to a vote and was carried unanimously.]

DR. RALPH HENDERSHOTT: In accordance with your mandate, it is my pleasure herewith to cast the unanimous vote of this Assembly for the following men for these respective offices:

President—Dr. H. F. Wilkins, Montana, for the year 1955.
First Vice President—Dr. A. L. Brueckner, Maryland.
Second Vice President—Dr. G. H. Good, Wyoming.
Third Vice President—Dr. John G. Milligan, Alabama.

PRESIDENT GREEN: Doctor West, will you escort Dr. Wilkins to the platform? Doctor Canty, will you escort Dr. Milligan? Doctor Good has left, I believe.

Doctor Wilkins, I wish to congratulate you and give you a charge, that in accepting this high honor you are accepting a great deal of responsibility. I mean that sincerely. As of right now, the health of the livestock of the United States rests heavily on your shoulders. I wish you the best of luck, and I know from my past experience in working with you that you are going to see that the job is well done.

Doctor Brueckner, my good neighbor, may I congratulate you. I know you will give everything there is in you to support our new President.

The same goes for you, Doctor Milligan. I know you are going to come out of the
ELECTION OF OFFICERS

Deep South supporting these boys with everything you have. Best of luck to all of you. [Applause]

DR. H. F. WILKINS: Now I can say “My Friends”. To me this is as great an honor as I could ever expect to receive. I would rather be President of the United States Livestock Sanitary Association, with all of its responsibilities, than President of the United States. I mean that sincerely.

With your help I hope my term in office will be a most successful one. I will look for a lot of help from all of you. Thank you very much for your generosity and for the honor. [Applause]

DR. A. L. BRUECKNER: I wish to take this opportunity to thank the members of this Association for the honor they have shown me in making me your First Vice President. As the years go by and as I attend more and more of these meetings, I learn more and more about the organization. I trust I will continue to do so. Thank you. [Applause]

DR. JOHN MILLIGAN: Fellow members, I wish to express my sincere appreciation for the honor that you have given to me today. I want to assure you that I will do all I possibly can to make the next year a success and to further the cause of the United States Livestock Sanitary Association. Thank you. [Applause]

[Dr. Wilkins assumed the Presidency.]

PRESIDENT H. F. WILKINS: Gentlemen, this closes the program for this year. We will meet again next year in New Orleans, and I hope the program then will be equally as good as this one has been, although it will be hard to beat it. This has been one of the finest meetings we have ever had. I have never seen a better feeling or heard better reports and papers that were better received, nor have I ever seen better feelings prevailing throughout the Association. It has been splendid, and I am very happy about it. I hope it will continue.

The meeting is adjourned.

[The meeting adjourned sine die at 3:40 p.m.]
CONSTITUTION AND BY-LAWS
OF THE
UNITED STATES LIVESTOCK SANITARY ASSOCIATION

ARTICLE I—NAME

The name of this Association shall be "The United States Livestock Sanitary Association."

ARTICLE II—PURPOSE

The purpose of this Association shall be the study of livestock 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 to the prevention, control and eradication of transmissible livestock diseases; to maintain co-ordination among the various livestock regulatory organizations, and to serve as livestock sanitary science clearing house between this Association and the following: 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. The word "livestock" as herein used shall be understood to include poultry.

ARTICLE III—MEMBERSHIP

There shall be two kinds of members—Official and Individual. The livestock sanitary departments of each State also the United States, and the Canadian, Cuban and Mexican governments, The Territories, Puerto Rico and the Virgin Islands shall be eligible to official membership in this Association and be represented on the Executive Committee by the livestock sanitary executive official. Any person engaged in livestock sanitary work for federal, provincial, state, territorial, county or municipal governments and any other person interested in livestock sanitation or milk and meat hygiene may be elected to individual membership.

ARTICLE IV—MEETINGS

The meetings of this Association shall be annual and special.

ARTICLE V—OFFICERS

The officers of this Association shall be: President, First Vice-President, Second Vice-President, Third Vice-President, Secretary-Treasurer, and an Executive Committee.

The officers of this Association shall hold office for one year or until their successors have been duly elected and qualified.

EXECUTIVE COMMITTEE

The Executive Committee shall be composed of the executive officer representing the livestock sanitary departments of the various States and Territories, the Chief
36 of the United States Bureau of Animal Industry, the Veterinary Director General 37 of Canada, the executive regulatory officer of Cuba and Mexico, The Territories, 38 Puerto Rico and the Virgin Islands, and the elective officers of this Association. 39 The Executive Committee shall constitute the administrative body of this As- 40 sociation and shall determine its activities and policies. 41 All recommendations and reports of officers and committees shall be referred for 42 consideration to the Executive Committee. 43 The First Vice-President shall be ex-officio chairman of the Executive Com- 44 mittee. 45 The Executive Committee shall elect yearly a Secretary-Treasurer for the As- 46 sociation. The Secretary-Treasurer shall receive such salary and allowance as may 47 be fixed by the Executive Committee. 48 The Executive Committee shall cause to be audited annually or oftener if deemed 49 necessary, the receipts and disbursements of the Secretary-Treasurer, and shall 50 have authority to hear and determine all complaints filed before it in writing rela- 51 tive to the conduct of any member; and shall have authority to accept or reject 52 applications for individual membership properly placed before them. Three nega- 53 tive votes shall disqualify for such membership.

ARTICLE VI — PROGRAM COMMITTEE

54 The President, the Chairman of the Executive Committee and the Secretary- 55 Treasurer and the Chairman of the respective committees shall constitute the 56 Program Committee. It shall be the duty of the Officers of the Program Committee 57 to make the necessary arrangements and provide the program for the annual and 58 special meetings.

ARTICLE VII — DUTIES OF OFFICERS

60 1. President: It shall be the duty of the president to preside at all meetings of 61 this Association; to appoint all committee excepting the Executive and Officer 62 fraction of the Program Committees; to call special meetings of the Association 63 whenever he considers the holding of such meetings necessary for the good of the 64 livestock industry or upon the written request of five members of the Executive 65 Committee. The president shall be an ex-officio member of all committees. 66 2. First Vice-President: The first vice-president shall be chairman of the Ex- 67 ecutive Committee. In the absence of the president, he shall preside at the meet- 68 ings of the Association. In the event of the absence, disability or resignation of the 69 president he shall perform all duties of the president. He shall be an ex-officio 70 member of the Executive and Program Committees. 71 3. Second Vice-President: The second vice-president shall assume the duties of 72 the president in the event of the absence, disability or resignation of the president 73 and first vice-president. He shall assume the chairmanship of the Executive Com- 74 mittee in the event of the absence, disability or resignation of the first vice-president. 75 He shall be an ex-officio member of the Executive Committee. 76 4. Third Vice-President: The third vice-president shall assume the duties of the 77 president in the event of the absence, disability or resignation of the president, first 78 vice-president and second vice-president. He shall assume the chairmanship of the
Executive Committee in the event of the absence, disability or resignation of the first and second vice-presidents. He shall be an ex-officio member of the Executive Committee.

5. Secretary-Treasurer: The Secretary-Treasurer shall keep an accurate record of the proceedings of the Association. Whenever authorized so to do by the Executive Committee he shall publish said proceedings and distribute them to the members of the Association. The Secretary-Treasurer shall also keep an accurate record of the proceedings of the Executive Committee and shall furnish a copy to each member of said Executive Committee. He shall forward to each Executive Committee member a copy of each regulation approved by the Association.

He shall keep an accurate account of all Association moneys received and disbursed. He shall also present to the Chairman of the Executive Committee a list giving the name, occupation and address of each applicant for individual membership for the approval of the Executive Committee. He shall perform such other duties as may be authorized and prescribed by the Executive Committee. He shall be ex-officio secretary of the Executive Committee, also an ex-officio member and secretary of the Program Committee. He shall be bonded for not less than ten thousand dollars.

ARTICLE VIII — AMENDMENTS

The constitution of this Association may be amended by a two-thirds vote of the members of the Association present and voting at an annual meeting, provided that the specific amendment to be acted upon shall have been presented in writing at a previous annual meeting and further provided that the amendment has received the approval of the Executive Committee.

BY-LAWS

ARTICLE I — ORDER OF BUSINESS

Registration.
Call to Order.
Report of Secretary-Treasurer.
President's Address.
Reading of Papers.
Committee Reports.
Discussion.
Unfinished Business.
New Business.
Nomination and Election of Officers.
Adjournment.

A suspension of the By-laws may be made by a two-thirds majority for the purpose of changing the order of business or to facilitate business.

ARTICLE II — APPLICATION FOR MEMBERSHIP

Applications for individual membership shall be made in writing to the Secretary-Treasurer. The application shall give the name, occupation and address of the app
applicant and shall be accompanied by a fee of three dollars ($3.00), which amount shall include the membership dues for one year. Applications shall be presented in proper form to the Secretary-Treasurer, who shall in turn submit them to the Executive Committee.

An individual member may be expelled for cause by the Executive Committee.

**ARTICLE III — MEETINGS**

The annual meetings shall unless otherwise determined not less than thirty (30) days in advance by a majority of the members of the Executive Committee, be held at Chicago, Illinois, during the time of the International Livestock Exposition. The place for holding the meetings in Chicago as well as the duration of said meetings shall be determined by the Officer Members of the Program Committee of the Association.

The place for holding special meetings shall be determined by the President with due regard to the wishes of the members of the Executive Committee, the subject matter to be considered, accessibility, and the information to be obtained. The notice of time and place of holding a special meeting shall be mailed to the members at least thirty days prior to the date fixed for the special meeting.

**ARTICLE IV — QUORUM**

Twenty-five members of the Association shall constitute a quorum. Five members of the Executive Committee shall constitute a quorum.

**ARTICLE V — DUES**

The dues for individual membership in this Association shall be three dollars ($3.00) per annum, payable in advance (on or before January 1st of each year) to the Secretary-Treasurer of the Association.

The dues for official memberships shall be fifty dollars ($50.00) each per annum, payable in advance (on or before January 1st each year) to the Secretary-Treasurer of this Association.
MEMBERSHIP ROSTER, U.S.I.S.A.

ALABAMA

Official member
John Milligan

Individual members
G. W. Cooper
M. L. Crawford
B. N. Lauderdale
John Milligan
C. H. Poitevint
W. C. Smith
J. B. Taylor

J. N. Fulmor
T. J. Hage
P. Haims
G. H. Hart
L. M. Hurt
D. E. Jasper
A. L. Kelly
R. C. Maris
B. McGowan
G. A. Railsback
S. T. Rich
A. S. Rosenwald
F. H. Saunders
K. Schaaf
O. W. Schalm
R. J. Schermerhorn
H. J. Schmidt
R. C. Schock
C. R. Schroeder
E. F. Sheffield
L. B. Tennison
A. L. Tietze
F. W. Wood

ARIZONA

Official member
J. A. King

Individual members
Circle One Livestock Co.
E. R. Cowden
N. M. Dysart
J. M. Jacobs
W. T. Lightle
C. H. Miller
D. Miller

ARKANSAS

Official member
Joseph S. Campbell

Individual members
C. C. Franks
R. H. Wilkinson

CALIFORNIA

Official member
J. E. Stuart

Individual members
R. A. Ball
J. H. Bouton
W. H. Boynton
F. M. Brennan & H. H. Laskey
California Cattlemen’s Association
H. S. Cameron
N. H. Casselberry
E. M. Christopherson
W. J. Cleveland
J. B. Enright
T. B. Eville

J. N. Fulmor
T. J. Hage
P. Haims
G. H. Hart
L. M. Hurt
D. E. Jasper
A. L. Kelly
R. C. Maris
B. McGowan
G. A. Railsback
S. T. Rich
A. S. Rosenwald
F. H. Saunders
K. Schaaf
O. W. Schalm
R. J. Schermerhorn
H. J. Schmidt
R. C. Schock
C. R. Schroeder
E. F. Sheffield
L. B. Tennison
A. L. Tietze
F. W. Wood

LOS ANGELES COUNTY

Official member
F. P. Wilcox

Individual members
R. H. Hurt
H. T. Ludwig
G. H. Murphy
F. P. Wilcox
W. A. Young

COLORADO

Official member
M. N. Riemenschneider

Individual members
W. A. Clark
Colorado Serum Company
C. L. Davis
N. Frank
R. M. Gow
R. M. McCullough
J. A. Palotay
M. N. Riemenschneider
L. Seghetti
### CONNECTICUT

**Official member**
Jean. V. Smith

**Individual members**
- J. W. Beck
- F. Ferrigno
- E. Jungherr
- J. V. Smith

### DELAWARE

**Official member**
Wm. R. Teeter

**Individual members**
- D. C. Boughton
- D. Francis
- J. C. Kakavas
- W. E. Reed
- K. C. Seeger
- W. R. Teeter
- H. J. White
- C. A. Woodhouse

### DISTRICT OF COLUMBIA

**Official member**
C. D. Van Houweling

**Individual members**
- C. L. Gooding
- O. E. Herl
- W. O. Kester
- A. K. Kuttler
- A. M. Lee
- C. D. Lowe
- J. J. Martin
- J. A. McCallam
- A. R. Miller
- C. H. Pals
- B. C. Pier
- A. F. Ranney
- H. W. Schoening
- B. Schwartz
- W. T. Shalkop
- B. T. Simms, Sr.
- L. A. Spindler
- C. D. Van Houweling
- A. E. Wight
- J. E. Williams

### FLORIDA

**Official member**
C. L. Campbell

**Individual members**
- J. A. Acree
- C. L. Campbell
- J. G. Du Puis
- J. G. Fish
- I. N. Habecker
- V. C. Johnson
- L. E. Swanson

### GEORGIA

**Official member**
T. B. Clower

**Individual members**
- J. S. Andrews
- P. F. Bahnsen
- L. O. Emik
- T. J. Jones
- A. K. Kleckner
- R. W. Menges
- C. J. Mikel
- L. A. Mosher
- M. D. Schneider
- W. L. Sippel
- L. E. Starr
- J. H. Steele
- J. M. Sutton
- E. S. Tierkel

### IDAHO

**Official member**
A. P. Schneider

**Individual members**
- O. I. Blain
- A. P. Schneider
- J. W. Stucki

### ILLINOIS

**Official member**
A. K. Merriman

**Individual members**
- W. A. Aitken
- J. O. Alberts
- American Shorthorn Breeders Association
- Armour and Company
- A. C. Atlason
- D. E. Bartlett
- C. E. Blye
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MEMBERSHIP ROSTER

J. F. Harr
J. A. Henderson
S. L. Hendricks
R. L. Houmes
E. D. Hubbard
T. B. Huff
W. H. Hurst
Iowa Farm Serum Company
G. S. Jones
J. M. Jones
A. H. Killinger
H. M. Kirk
J. H. Krichel
V. D. Ladwig
C. D. Lee
W. A. Liebsch
P. J. McAndrew
H. L. McCrillis
H. E. McCutchan
P. C. Molgard
B. A. Moore
D. E. Moore
T. W. Munce
G. B. Munger
H. S. Nicol
W. H. Olson
W. A. Parks
E. E. Ragan
A. N Richey
J. G. Salsbury
J. E. Salsbury
H. P. Sandberg
E. Schneckloth
L. H. Schwarte
L. R. Sinclair
L. R. Smith
M. L. Spear
J. P. Torrey
H. M. Wallace, Jr.
W. V. Wittern
J. P. Woodbridge
W. D. Yoder
F. B. Young
P. D. Cazier
L. M. Curts
R. R. Dykstra
V. D. Foltz
W. J. Gough
A. Kushner
E. E. Leassure
W. L. Ljungdahl
R. L. Merz, Jr.
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