THE MONTANA STATE BOARD OF ENTOMOLOGY

EIGHTH BIENNIAL REPORT

1929 - 1930

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W. F. Cogswell, M. D., *Secretary State Board of Health,*
Chairman, Helena, Montana.

W. J. Butler, D. V. S., *State Veterinary Surgeon,*
Member, Helena, Montana.

R. A. Cooley, *B. Sc., State Entomologist,*
Secretary, Bozeman, Montana.

LETTER OF TRANSMITTAL

Bozeman, Montana, January 6, 1930.

To His Excellency, John E. Erickson,
Governor of Montana,
Helena, Montana.

My dear Sir:

The services of the *ex-officio* Montana State Board of Entomology have continued without interruption since 1913. There has been no change in the personnel of the Board. There has been a determined effort to bring spotted fever under control and real progress has been made, for what has been done will not have to be done over again. At the same time, spotted fever is spreading in Montana and in other western states and at the present time is far more of a problem than it was when the Board of Entomology took up its duties. It is now recognized both in Montana and other western states that the problems of Rocky Mountain spotted fever, tularaemia and tick paralysis, all of which are produced by the wood tick of this region, are not problems for Montana alone but apply as well in some twelve other states. Accordingly, in recent months an effort has been made to turn the entire research program of the Board of Entomology over to the United States Public Health Service. It is proposed also to turn over the Hamilton Laboratory to them. This laboratory would thereby become the headquarters for the study of tick-borne diseases in the western states, and the expense of the research work would be borne by the Federal Government.

It has been necessary for the Board of Entomology to ask for a continuance of the present appropriation for it is not at all assured that the program to turn over the work to the Government will go through. In case the plan does carry, the appropriation will be expended only in so far as it applies to "control work" which has to be distinguished from the research work. It will be necessary for the Board of Entomology to continue its control program, which includes the destruction of rodents, the dipping of livestock and enforcement of quarantines until such time as a more suitable method of controlling ticks or spotted fever has been discovered.

It is recommended that this report be published as the Eighth Biennial Report of the Montana State Board of Entomology.

Most respectfully,

R. A. Cooley, Secretary.

CONTENTS

ACTIVITIES IN 1929-1930

The activities of the Montana State Board of Entomology during the Biennium now closing may be summarized as follows:

1. Continuation of the plan of informal cooperation with the Bureau of the Public Health Service.

2. Continuation of the tick parasite project.

3. Continuation of the dipping of domestic animals and of the killing of rodents by poisoning in the control districts in the Bitter Root Valley.

4. Promotion of a plan to turn over the entire work of the Board, excepting "control work," to the United States Government.

SUMMARY FOR 1929-1930

The Montana State Board of Entomology created by the Thirteenth Legislative Assembly in 1913, has made a continuous and determined effort to bring the wood tick *(Dermacentor andersoni* Stiles) and the human disease, Rocky Mountain Spotted Fever, under control. The Act creating the Board made the Secretary of the State Board of Health, the State Veterinary Surgeon and the State Entomologist *ex officio* the members to constitute the Board. During this period of eighteen years there has been no change in the personnel of the Board, and the three members have given much time and thought to the work. To a certain extent also the resources of the three separate departments of Service in the State have been brought to bear on the joint problem assigned to them.

When the work was started by the Board it was little realized that it would be so long-drawn out, although it was understood at the first that the problem was a complicated one. Now, after these years of labor, it becomes necessary to say quite frankly that the problem is far from being solved, and Rocky Mountain Spotted Fever is still a real public health problem in Montana, and meantime it has both spread and been recognized far and wide in Western United States and is now a problem in at least thirteen separate states.

At the same time it is very gratifying to state that real progress has been made. Previous to the creation of the Board of Entomology, Ricketts alone and McCalla and Brereton working together, publishing simultaneously, had shown that the wood tick does in fact transmit Rocky Mountain Spotted Fever to man, as had been suspected by Wilson and Chowning; and the State Entomologist of Montana and the U. S. Bureau of Entomology had worked out the biology of the wood tick with fair completeness. The high points of accomplishment since the Board's work began are: the naming and describing of the organism of the disease by Wolbach; the discovery and quantity manufacturing of the Spencer-Parker vaccine; and the starting of a definite tick parasite project. These few high points of progress do not at all adequately

cover the accomplishments. A tremendous volume of work, more arduous and dangerous than the world will ever know, has been done by such men as Ricketts, McClintic, Fricks, Wolbach, Noguchi, Spencer, Parker and others, including a long list of associates and assistants, and the aggregate of their accomplishments has gone far toward accomplishing the desired solution. In a very complicated problem like the present one, it is only natural that a considerable portion of the results of well laid out researches should be of only intermediate value leading gradually toward the final end desired, namely, the eradication or complete control of the disease. These secondary results are of great scientific interest and many valuable publications have resulted. Not the least of these results have been the contributions made by Parker and Spencer of the Public Health Service staff at Hamilton, to our knowledge of tularaemia and tick paralysis, two other definite human diseases communicated to man by the bite of the same tick. All or most of this preliminary work was necessary and will not have to be done over again.

These studies have been made in a new field of knowledge where there was very little in the published results of previous workers to guide new workers, and to a remarkable degree, particularly in recent years, each new discovery made has appeared to complicate the problem rather than to simplify it, with the result that the workers have been continually finding it necessary to set up new studies and experiments. They could easily become hopelessly confused and ineffective in their further efforts, were it not for the fact that they are thoroughly trained, much experienced and held by a rare devotion to the work.

THE COOPERATION WITH THE UNITED STATES PUBLIC HEALTH SERVICE

Since the earliest years of the investigations of Rocky Mountain Spotted Fever the United States Public Health Service has taken an active part. The reader is referred to the Seventh Report, in which, on page 69, is a short review of this subject written by Doctor W. F. Cogswell. For most of the period since the Board of Entomology was organized the Public Health Service has had a research worker, or a research organization, stationed in Montana for the study of this disease. Thus, in 1913, when the Board began its labors, Doctor L. D. Fricks began his studies with headquarters at Victor, and continued until 1917. In 1921 Doctor R. R. Parker, who previously had been employed by the Board of Entomology, was taken over by the Public Health Service and a larger laboratory was established near Hamilton. In the spring of 1922 he was joined by Doctor R. R. Spencer who had been detailed in charge of the Rocky Mountain Spotted Fever studies. Doctor Spencer thereafter divided his time between the Service's field station at Hamilton and the Hygienic Laboratory in Washington until September, 1928, when he was assigned to duty at the latter institution. During this period, there was the closest cooperation between Doctor Spencer and Doctor Parker, and in 1930 there appeared a very valuable publication from the Public Health Service giving the results of over six years of joint research(1). These contributions, of which the most important was the Spencer-Parker vaccine, have been of the greatest value. Though now stationed at Washington, Doctor Spencer continues to maintain an active interest in, and is still devoting a part of his time to, spotted fever studies.

Doctor Parker, who served under the Board of Entomology from 1915 to 1921, and who has since been with the United States Public Health Service, and is now directing its operations at Hamilton, has without doubt spent more time in the study of Rocky Mountain Spotted Fever than any other man. A tremendous worker, with extraordinary capacity for orderly detail and with unfailing devotion and enthusiasm, he has accomplished much. During his continuance in Montana he has been lone author of eighteen scientific papers on Rocky Mountain Spotted Fever and closely related subjects, and of twenty-five in joint authorships, principally with Doctor Spencer. In addition to these he has written alone thirty-one scientific articles on other subjects in entomology, or a total of seventy-four titles while working in Montana.

We have referred to our plan of cooperation as being an informal one. In recent years the Board of Entomology has devoted its attention and funds mainly to the tick parasite work, the destruction of rodents, and the dipping of domestic animals. The Public Health Service has its own program of work which includes the production of the Spencer-Parker vaccine on a rather large scale, and researches in the laboratory and in the field. The Spencer-Parker

(1) Spencer, R. R. and Parker, R. R. Studies on Rocky Mountain Spotted Fever. Hygienic Laboratory Bulletin No. 154, January, 1930.

vaccine has been supplied to the other western states as well as to Montana. The Board of Entomology and the representatives of the Public Health Service have had frequent conferences, and throughout the history of the cooperation there has been the freest possible exchange of ideas.

It is only natural that this branch of a Government Institution should engage to some extent in other lines of work closely related to the spotted fever problem and even more natural and necessary that work should be done in other states as well as in Montana. The whole project has grown greatly in recent years, and the Montana Laboratory has quite unavoidably become the headquarters for the Government work on Rocky Mountain Spotted Fever and other tick-borne diseases in the Western United States.

While on duty in these studies in Montana the following became accidentally infected with Rocky Mountain Spotted Fever and made the supreme sacrifice:

Doctor Thomas B. McClintic
Doctor Arthur H. McCray
William E. Gittinger
George H. Cowan
LeRoy Kerlee

All of these excepting Kerlee died before the Spencer-Parker vaccine was discovered. Since the days of vaccination there have been at the Hamilton Laboratory eight vaccinated cases of spotted fever contracted by accident, which have recovered. Before the days of vaccination all laboratory cases died. In addition to these must be mentioned eleven laboratory cases of tularaemia, all of which recovered.

And yet the work goes on.

What shall we say of the some twenty-five workers who, fully appreciating the dangers incident to the daily routine, still continue at a rate of compensation not higher than the gain in other kinds of work in which these dangers are lacking. We may say, at least, that idealism and the spirit of sacrifice for the general good have not died out.

ORGANIZATION AND PERSONNEL

THE STATE BOARD OF ENTOMOLOGY

Doctor W. F. Cogswell, Secretary, State Board of Health, Helena, Chairman.
Doctor W. J. Butler, State Veterinary Surgeon, Helena.
Professor R. A. Cooley, State Entomologist, Bozeman, Secretary, and in Charge of Tick Parasite work.

Staff of the Board of Entomology
Hamilton, Montana

Mr. F. J. O'Donnell, Field Agent.
Mr. Glen M. Kohls, Assistant Entomologist.
Mr. Fred A. Morton, Assistant Entomologist.
(For a period of 3 months in 1930.)
Mr. Harley Sargent, Field Assistant.
Mr. Nick Kramis, Laboratory Attendant.
Mr. Carl Larson, Laboratory Attendant.
(For a period of 3 months in 1930.)
Miss Marie W. Symington, Clerk.
Mr. P. M. Gillis, Janitor.

Field Crews on Rodent Control in 1930

Mr. F. P. Merritt, Supervisor.
Mr. Lloyd Merritt, Supervisor.
Mr. E. O. Everson, Supervisor.
Sixteen Field men.

UNITED STATES PUBLIC HEALTH SERVICE
Hamilton, Montana
(As of December, 1930)

Doctor R. R. Parker, Special Expert, Officer in Charge.
Doctor C. B. Philip, Associate Entomologist.
Doctor G. E. Davis, Bacteriologist.
Doctor Herbert Hayward, A. A. Surgeon.
Mr. Wm. M. Jellison, Assistant Bacteriologist (Resigned).
Mr. T. M. Sheehy, Senior Clerk.
Miss Selma C. Helvik, Typist.
Mrs. Ruth Romney, Typist.
Mr. E. W. Malone, Laboratory Assistant.
Mr. A. E. Whitcomb, Laboratory Assistant.
Mr. J. D. Kerlee, Laboratory Assistant.
Mr. F. B. Thrailkill, Field Assistant.
Mr. W. S. Willey, Field Assistant.
Mr. M. L. Nolan, Laboratory Attendant.
Mr. W. T. Smith, Laboratory Attendant.
Mr. P. M. Gillis, Janitor.

In addition to the above there have been employed by the Public Health Service a number of temporary employees for such special services as Draftsman, Meteorological Observer, Seamstress, Field Assistant, Laboratory Assistant and Laboratory Attendant.

ROCKY MOUNTAIN SPOTTED FEVER OUTSIDE OF MONTANA

Rocky Mountain Spotted Fever is not a public health problem of Montana alone. The same may be said of tularaemia and tick paralysis, a little understood malady generally affecting children, and always ending fatally unless the tick is found and removed. The wood tick of this region is, in part, responsible for tularaemia and wholly responsible for tick paralysis. It has been known for many years that spotted fever is present in other states, notably in Idaho, Wyoming, Nevada, Oregon, and Utah, but its geographic distribution and the number of cases were not known. In recent years Doctor R. R. Parker, of the Public Health Service, has given careful attention to tracing out the records of cases of Rocky Mountain Spotted Fever in the Western States and has added very much to our knowledge of this subject. It is evident that in many localities the disease had existed for many years before its identity was recognized by practicing physicians. There is evidence also that the disease has been actually spreading to new areas. We know more about the epidemiology of spotted fever in Montana than in any other state for we have given extended attention to the subject in this state. Before the year 1914, cases had been reported only from three endemic areas in Montana, occupying parts of Ravalli, Missoula, Granite and Carbon counties, two of these areas being close together in Western Montana and one in an isolated position in Eastern Montana, across the Continental Divide but continuous with infected areas in Wyoming. In 1914 reports of cases began to come in from all over Montana and in every year since, the reports have continued until now we have had cases in 39 of the 56 counties of the state. There is evidence also that the disease is becoming increasingly virulent in some localities. During 1930 it was reported that in a certain restricted locality in Idaho which had been developed as a place for summer camping and recreation, there had been seven cases and five deaths this year alone. This is to be contrasted with the previous figures from Idaho showing a death rate of only 4.86 per cent (as computed by Maxey, 1908).

From unpublished work of Doctor Parker, of the United States Public Health Service, there is reason to believe that Rocky Mountain Spotted Fever has stepped across the boundary of the territory in which quite a different tick occurs. This other tick, "The Eastern Dog Tick" *(Dermacentor variabilis* Banks), occurs all over the eastern half of the United States, the western limit of continuous distribution being along a line extending from a point on the Mexican boundary, a little west of the southern point of Texas, northward to the Canadian boundary near the state line between Montana and North Dakota. This tick is also found in California and southern Oregon. If the disease has established itself in the Eastern Dog Tick and if it continues to spread eastward it may, unless stopped, eventually involve some, at least, of the more densely populated eastern and southern United States.

PROPOSAL TO SURRENDER THE BOARD'S RESEARCH WORK TO THE UNITED STATES GOVERNMENT

Under authority from the State of Montana, the three members of the State Board of Entomology attended the meeting of the Western Branch of the American Public Health Association held in Salt Lake in June, 1930. It had become apparent that while for many years the State of Montana had been engaged in studies on Rocky Mountain Spotted Fever and had expended some $300,000, the time had arrived when the other states in the Western United States should take an active part in the studies and particularly in the use of tick parasites. The board had no very definite program in mind at this time but it did suggest to the meeting that a Rocky Mountain Spotted Fever Committee be named. Accordingly, the following committee was constituted:

Doctor Wm. C. Hassler, President, Western Branch, American Public Health Association.

Doctor F. W. Almond, Idaho, State Health Advisor.

Doctor Albert B. Tonkin, Wyoming, President State Board of Health.

Doctor A. U. Simpson, Washington, Epidemiologist, State Board of Health.

Doctor W. F. Cogswell, Montana, Secretary State Board of Health.

Doctor W. M. Dickie, California, Secretary State Board of Health.

Doctor R. J. Stroud, Arizona, Secretary State Board of Health.

At a meeting of the Board of Entomology held at Hamilton on August 6, 1930, further attention to the general welfare of the work was given. It was apparent that Rocky Mountain Spotted Fever is spreading and is not a local problem affecting Montana alone, and that the expense of maintaining the work has become a burden to Montana. It was further apparent that it was only natural to turn the research program over to the United States Government. Accordingly, the following resolutions were unanimously adopted:

WHEREAS, The State of Montana took the initiative in the serious study of Rocky Mountain Spotted Fever and has erected a Laboratory especially designed for the study of this and other tick-borne diseases and has expended approximately three hundred thousand dollars in these studies, and

WHEREAS, With the growth and development of the work the problem has become an interstate problem affecting at least thirteen states (Washington, Oregon, Idaho, California, Nevada, Montana, North Dakota, South Dakota, Nebraska, Wyoming, Colorado, Utah and New Mexico), and

WHEREAS, The other affected states, in the past, depended on Montana and have not expended funds in researches in Rocky Mountain Spotted Fever and, while recognizing the desirability of centralizing the work at some one headquarters, it would be impossible for the several states to expend funds outside their own boundaries and erect a centralizing agency of their own, and

WHEREAS, The United States Public Health Service, beginning in 1903 and continuing to the present time, and more especially in recent years, has made very valuable contributions to our knowledge of Rocky Mountain Spotted Fever and other tick-borne infections, and

WHEREAS, The United States Public Health Service has originated and is now manufacturing an effective vaccine for Rocky Mountain Spotted Fever, the demand for which is very rapidly increasing in the several affected states, and

WHEREAS, This vaccine is the only vaccine in the world made from ticks or insects, and because of the peculiar and special circumstances can never be made by any of the large biological houses, and

WHEREAS, The United States Public Health Service, in view of all the circumstances, is the logical centralizing agency for the future conduct and

developing of the research work in Rocky Mountain Spotted Fever and other tick-borne diseases in the several states in the West which are concerned in this problem, now

Therefore, Be It Resolved that the Montana State Board of Entomology unanimously recommends to the Surgeon General of the United States Public Health Service:

1. That the Service establish a branch laboratory in Montana for continuing the researches on Rocky Mountain Spotted Fever and for such other purposes as they may think desirable.
2. That they take over from the State of Montana the present laboratory.
3. That they enlarge the present laboratory facilities.
4. That they establish in connection with the laboratory, at some point on the west side of the Bitter Root River, a field station or experimental farm where larger animals may be infested with ticks and where infected ticks may be reared for the production of the Spencer-Parker vaccine.
5. That they take over all the branches of the spotted fever researches, including the tick parasite work, but not including control work (such as rodent destruction, dipping of domestic animals, quarantine, etc.).

On September 24, 1930, the Rocky Mountain Spotted Fever committee mentioned above met with the Board of Entomology at Hamilton and made a careful study of the research and control work in progress, and discussed the entire situation. This committee adopted resolutions for later presentation to the American Public Health Association, as reported below. This committee also adopted the following resolutions:

Be It Resolved that this committee takes this opportunity to express at this time the appreciation of our separate states, for the unselfish efforts of the tax payers of the State of Montana through their law-making bodies and the Montana State Board of Entomology and the Montana State Board of Health, in the expenditure of considerable money and work in the study and control of Rocky Mountain Spotted Fever, out of which great benefit has accrued to our separate states and for which we are, and should be, truly grateful; and

Be It Further Resolved that this committee expresses its appreciation of the persistence of the members of the Montana State Board of Entomology and Montana State Board of Health, over the period of these years in laboring on this problem in the face of repeated discouragements, for out of this unselfish work and devotion to the cause has come much of our progress that has now been made with regard to the achievements in control of this disease.

The Chairman and the Secretary of the Board of Entomology were present at the Annual Meeting of the American Public Health Association held at Fort Worth, Texas, October 27-30, 1930, for the purpose of further promoting the plan to turn the work over to the United States Government. A very ready response was met with from this very large body of health workers from all over the United States, Canada and Mexico. Some two thousand health workers were present. The following resolutions presented by the Western Branch were unanimously adopted:

WHEREAS, For the past twenty-eight years the State of Montana has been actively engaged in the study and control of Rocky Mountain Spotted Fever and other tick-borne diseases at an expenditure of approximately $300,000, and in 1928 erected a new and modern Laboratory at Hamilton, Montana, at a cost of $60,000 without financial aid from the other infected States; and

WHEREAS, The Bureau of the Public Health Service, cooperating with the State of Montana, has discovered and is making an effective vaccine from a

highly virulent local strain of ticks and with enlarged facilities could increase the production of this vaccine to meet the growing demand; and

WHEREAS, The Montana State Board of Entomology is engaged in the use of imported tick parasites and believes that the use of such parasites offers the most practical and most promising method of control of ticks; and

WHEREAS, The problem of ticks and of the human diseases which they transmit is not a local one affecting Montana only, but affects as well the following States: Washington, Oregon, Idaho, Colorado, Wyoming, Utah, California, and Nevada, and is threatening the adjoining states of North Dakota, South Dakota, Nebraska and New Mexico, and is a potential menace to all of the States of the Union; and

WHEREAS, The Public Health Service has for many years been engaged in the study of this group of tick-borne diseases; and

WHEREAS, It is the expressed desire of the State of Montana that this work be turned over to the Bureau of the Public Health Service;

Therefore, Be It Resolved that the Surgeon General of the Bureau of the Public Health Service be requested to take over and assume full control of investigations of tick-borne human diseases and of the control of ticks by parasites; and

Be It Further Resolved that Congress be requested to pass an Act authorizing the Bureau of the Public Health Service to take over the Laboratory located at Hamilton, Montana, and extend the scope of the work as may be deemed necessary by the Surgeon General of the Public Health Service.

From the foregoing it is evident it is the wish and the recommendation of the Board of Entomology to turn over the Board's work excepting "control" and including the tick parasite work, along with the laboratory at Hamilton owned by the State of Montana, to the National Institute of Health which was set up by the Ransdell Bill of Congress passed in May, 1930. If an Act of the Montana Legislature is required, it is recommended that such an Act be passed.

THE FUTURE OF THE BOARD OF ENTOMOLOGY

It is necessary to consider what is to be the future of the Board of Entomology in case the United States Government takes over the entire research program. The logical, and in fact the necessary line of division to be made is between "research" and "control." The further research work on spotted fever and related subjects and on tick parasites is going to be necessarily expensive and at the same time the results will be applicable at once in many other states, and, perhaps to the whole of the United States. The control work includes the killing of rodents, the dipping of domestic animals, the control of the movements of domestic animals by State quarantine laws and otherwise, and such other similar projects as the research program may bring to light. It is quite possible that the several states may find it necessary to modify their game laws. All such projects aimed directly at control should be under state rather than national supervision.

The Montana State Board of Entomology should be continued, provided this plan carries, though it will not need as large an appropriation as in the past.

Again, the State of Montana, provided the government does take over the research and parasite work, will find it to its own advantage to maintain what may be termed a contact organization for conferences with the government representatives. The Board of Entomology will serve this purpose in Montana. Other states may find it desirable to establish such contact organizations.

REVIEW OF TICK PARASITE WORK FOR 1929 AND 1930

By R. A. Cooley

SUMMARY

The work of the Montana State Board of Entomology in the attempt to colonize the French Tick Parasite, *Ixodiphagus caucurtei* DuB., during the biennium now closing, has been conducted in much the same manner as previously. Parasites have been used in quantity, and have been liberated in selected localities in both western and eastern Montana. Experiments and observations have been made to determine if the parasites are surviving our severe winters and attacking the wood tick. Other studies have been made in the field and in the laboratory intended to make the parasite project more effective, and to determine if the parasites are capable of carrying diseases from tick to tick.

QUANTITY REARING OF PARASITES AND TICKS

The rearing of parasites has been continued, the same methods being used as reported in the Seventh Biennial Report (see p. 32, "Quantity Production of Tick Parasites," by Fred A. Morton). The numbers of parasites have been greatly increased, however, and it is planned that the annual production in 1931 will be increased at least three-fold.

In order to grow the parasites it is first necessary to grow the ticks on which, or in which to feed them, and since it is essential that only non-infected ticks be used, it is necessary to take great pains that the tick stocks shall not become infected with any disease. Formerly we bought fully fed female ticks from farmers living in regions of the state supposed to be free of both spotted fever and tularaemia. Some infection crept in, however, making it necessary to discard a considerable portion of the stocks and since that time the complete work of rearing the ticks has been done in the laboratory. The unfed, "flat," adult ticks are fed on rabbits and the fully engorged females are recovered and stored in one of the thermal cabinets at a temperature of 38 to 45 degrees F. Mr. Kohls has found that the fed females can be stored without loss, thus making it possible to do this part of the year's routine at a time when other work is less pressing. A remarkable development is the skill with which Mr. Kohls and Mr. Morton are able to hold living stocks of both ticks and parasites in all stages in the thermal cabinets.

In another part of this Report will be found a paper by Mr. Kohls, detailing the parasite liberation.

Recovery of Parasites from Nature

It is of much importance to know whether the parasites which have been liberated have attacked the wood tick in nature. During the season of 1929, without making any extended effort to get information on this point, some living ground squirrels and chipmunks were captured in a parasite liberation area, taken to the laboratory and held in cages until the attached ticks had

completed their feeding. In some of the ticks, parasites developed showing that they had survived the winter and attacked the ticks.

In the season of 1930 ground squirrels and chipmunks were captured in the Lick Creek area but instead of taking them to the laboratory they were held in cages in an improvised rearing room in a tent in the field. When the ticks had completed feeding and were recovered, they were taken to the laboratory and held under observation. A total of 133 rodents were trapped in the Lick Creek area and these yielded 199 nymphae. The trapping was done from June 10 to July 30, which embraces a considerable portion of the season for active nymphae.

It is necessary to report that no parasites were recovered in 1930. The failure to demonstrate the presence of parasites in the Lick Creek area in 1930, on first thought, may be taken to mean either that the preceding winter had killed off the hibernating insects or that the parasites are not attacking the tick in a state of nature. Either of these may be true, of course, but it is yet too early to draw any conclusions. As related above, parasites were recovered the year before but we now consider that finding to be a piece of rare good fortune. The question is of the greatest interest, and for this reason some other facts should be mentioned.

It is entirely possible that the parasites are present in a living condition but that we have failed to recover them merely because they have dispersed so rapidly that capturing a few animals within the liberation area could scarcely be expected to yield any of them. We have placed out overwintering experiments in both eastern and western Montana every winter since we began the parasite program and have found a percentage of the parasites alive each spring in both ends of the state. Furthermore, we are using as stock, parasites that have been reared from such parasites as have survived one or more winters in the out-of-doors. It is a well known fact that immediately following the introduction of a new insect, the numbers present are so small as to easily escape detection. The speed with which an introduced parasite can multiply to numbers sufficient to overcome the host insect, or to be detected, will depend on many factors. Some of these are the following: (1) the rapidity with which the parasites are able to multiply and overtake the host; (2) the rapidity with which the host can multiply and so escape being overcome; (3) the correlation between the habits or seasonal histories of the parasite and the host; (4) the rate of dispersal of the parasites; and (5) the climate.

Rate of Multiplication of Parasites

It has not been possible to obtain as yet any reliable information on the rate of increase of the parasites in nature. All such studies on this parasite are expensive and the results elusive.

To obtain information on the ratio between males and females in the parasites, the computations shown below were made.

Parasites Counted	Males	Females	Per Cent Females
173	65	108	62.5
216	75	141	65.3
276	83	193	70.0
320	95	225	70.4
Average	318	667	67.0

It is thus shown that the females predominate in the ratio of 67 to 33.

Experiments were conducted by Mr. Kohls for the purpose of determining the number of offspring of one parasite under laboratory conditions. Female parasites were placed in tubes with unfed nymphae and allowed to remain for twenty-four hours. The nymphae were then caged in rabbits' ears to prevent loss of ticks and when recovered were watched for parasitism. The results of this experiment are tabulated below.

Lot No.	Females Used	Parasitized Nymphs Obtained	Total Parasites Obtained	Average Parasites Per Nymph	Number of Nymphs Fed	Per Cent Parasitized
1	1	7	32	4.5	73	9.5
2	1	2	14	7.0	81	2.4
3	1	14	90	6.4	79	17.7
4	2	3	18	6.0	21	14.2
5	2	19	132	6.9	49	38.7

It will be observed that the numbers of offspring produced by individual females is not large but it must be borne in mind that the conditions of the experiment are wholly artificial. The parasites were exposed to flat nymphae in a tube instead of to feeding nymphae on a host animal. It is doubtful if it will be possible ever to get truly reliable data on the potential rate of increase, though the actual rate of increase may be approximated by trapping animals in nature and determining the percentage of parasitized ticks. Even these results will be influenced by the high rate of dispersal discussed below.

In this connection it should be mentioned that even when, in the laboratory, the parasites are confined in bags with the ticks feeding on rabbits or other animals, a large number of ticks escape being parasitized. In the table above it will be seen that the per cent parasitized ranged from 2.4 to 38.7. Again it is to be remembered that the conditions are unnatural and we cannot say what the rate would be in a state of nature. The present writer had previously crushed the ovaries under a microscope and shown that the number of eggs is enormous. It was quite impossible to count them.

Rate of Multiplication of the Tick

The factors influencing the multiplication of ticks are very complex and cannot be discussed at length in this place. In such a locality as the mountains surrounding the Bitter Root Valley where the ticks have been present for a great many years, probably since long before white man arrived, and have had opportunity to increase to their maximum numbers, it may be said that a state of balance has been reached. In such a state there is a certain unknown average rate of tick population per square mile. Through the years, while there are more ticks in some seasons than in others, it may be said that there are so many ticks per square mile, and the numbers have an average constant. To one who has given attention to the wood tick, it is easily understood that there must be very powerful factors at work which tend to kill off the ticks in the course of their development from the egg stage to the adult stage. Many are killed by heat, cold, desiccation and by failure to find a host. The same is true in a large measure of all ticks. Through natural selection ticks have adapted themselves for survival by producing a large number of eggs. More must make the start since the chances are so small that any one individual making the start will ever reach maturity and reproduce. The eggs from five females recently counted showed numbers to be 5196, 6820, 8574, 7971, and 3361. The average of these five counts is 6384.5 which may be taken as repre-

senting approximately the offspring of one pair of ticks. A count of both male and female ticks in a mixed lot of 1118 ticks showed that there were 558 males and 560 females. We may therefore reason that in a balanced state such as is mentioned above, the chances are as 1 to 3192.25 that any one egg laid will ever reach the adult condition and reproduce.

If ticks are introduced into a new locality it will take time for them to reach their maximum abundance or establish a balance. Similarly, if parasites are liberated in a balanced tick community, the balance is upset. It is readily seen that the rate of multiplication of the ticks in a balanced community will be different from that in an unbalanced one, and that the rate at which the parasite population will overtake the tick population will be affected. In a balanced community of ticks where parasites tend to reduce the numbers of ticks, the ticks will tend both to increase because of greater natural opportunity to multiply, and to decrease because decimated by the parasites, and the speed with which the parasites can overtake the ticks will depend upon their relative powers of multiplication.

Correlation of Habits

One of the factors affecting the rate of multiplication of the parasite is the correlation between the habits, or seasonal histories, of the ticks and of the parasites. We have shown that the adult parasites will lay their eggs in both larval and nymphal ticks as they are feeding on their host animals. It would be desirable that the adult parasites appear in their maximum numbers at the same season of the year when the appropriate stages of the tick are out in greatest abundance. We are accumulating information on these points in different parts of the state, and cannot state at the present time how favorable the correlation factor will be.

Rate of Dispersion of Parasites

Quite naturally the parasites tend to scatter or disperse from the locality in which they are at first planted. This will affect them favorably as regards their rate of multiplication, for by scattering they may increase their food supply. This same dispersion, however, will tend to prolong the time required for the numbers of the parasites to overtake the numbers of the ticks in the locality where the parasites are first planted. The parasites will tend to disperse more rapidly because the ticks on which they feed are carried on the hosts of the ticks (rodents chiefly) and will naturally tend to scatter as far as the animals may go in their ordinary movements and migrations.

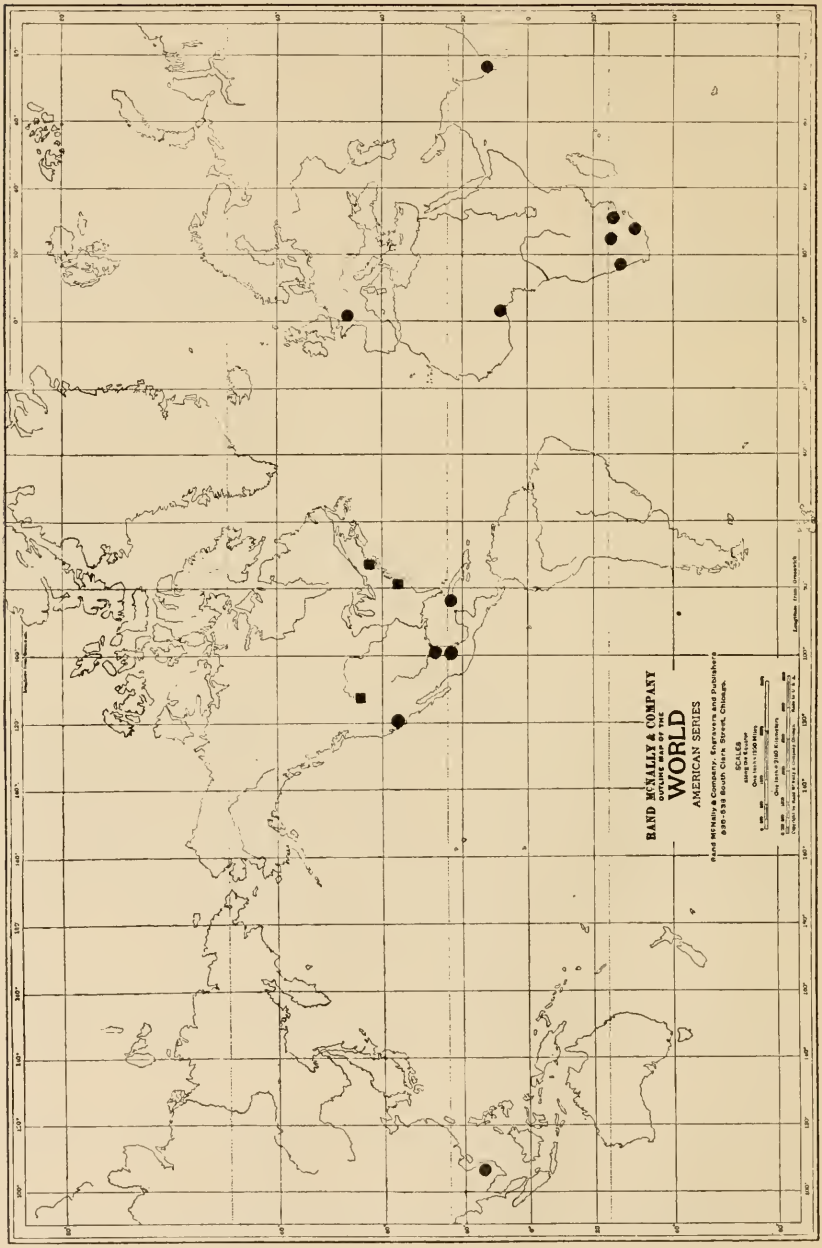
Influence of Climate

The climate of Montana has a bearing on the probability of success with the tick parasites, not only as affecting the survival of the hibernating insects in the winter but as governing the number of generations of the parasites that may take place in one season.

Tests to determine if the parasites can survive our winters have been made each year since the work on parasites was started in 1926. These tests have been made in western, central and eastern Montana, and it has been found that a large percentage of the parasites survive our winters.

A considerable amount of work has been done to determine the responses of both the tick in various stages and the parasite, to controlled temperature

Figure 1. Circles show where *Ixodiphagus* and *Hunterellus* have been found in the world. Squares show where attempts have been made to colonize *Ixodiphagus caucurtei* DuB.



in thermal cabinets. The detailed results will be published at another time. We have shown that at optimum temperatures of approximately 21 degrees C. the parasites will pass through the cycle from the egg to the adult in about 45 days. It has been shown further that colder temperature retards development greatly. This has been shown both in thermal cabinet tests and field tests. In field tests, parasites placed out in nature from May 14 to July 2, or over a period of 49 days, produced adults emerging during a period of 16 days from August 13 to August 29. Those placed out May 14 produced adults in 91 days, while those placed out July 2 produced adults in 55 days. It is thus apparent that the summer temperatures in the Bitter Root Valley are not far from optimum but that those of the spring months are far below optimum. As nearly as we can determine at the present time, we may expect one generation of parasites in Montana's climate under ordinary circumstances, though in exceptional seasons there may be two generations.

It is highly desirable to determine the effects of such climates as those of southern Idaho and Utah.

The accompanying map of the world will indicate by circles all of the localities where parasites of the genus *Ixodiphagus* have been collected. The squares indicate where attempts have been made to establish the parasite artificially. It will be seen that *Ixodiphagus* has been taken in a wide range of climates.

Parasitism of Larvae and Nymphae Compared

It has been shown elsewhere(1) that the adult parasites lay their eggs in engorged larvae as well as in engorging nymphae. Further information on this subject was obtained through experiments conducted at the Hamilton laboratory. The work of rearing was done by Mr. Glen M. Kohls.

On February 3, 1930, four rabbits were infested with larvae of *D. andersoni* Stiles and on February 5 the same four animals were infested with nymphae. Adult parasites were released on the animals on February 6, at room temperature, and each animal was tied in a separate "infesting bag" of muslin, 12 by 18 inches. The animals were kept in these bags for 24 hours after the parasites had been released.

There were recovered 7000 fed larvae and 980 fed nymphae from these four rabbits. The fed nymphae were held at 22 degrees C. and watched for development of parasites. By March 11, the parasitized nymphae could all be detected and it was determined that the fed nymphae were 80.9 per cent parasitized.

The fed larvae were held at 22 degrees C. for a period of two months beginning February 8, when they were placed in a "longevity tube" in the tick yard out-of-doors. On June 13, about four months after the date of parasitizing, the resulting flat nymphae were placed on a rabbit for feeding. There were recovered after feeding 212 engorged nymphae which were placed at 22 degrees C. to allow the parasites to mature. On July 24, 126 parasitized nymphae, or 59.4 per cent of the fed nymphae, were recovered. It should be noted that it is possible that the long holding of the nymphae may have reduced the percentage of ticks in which the parasites matured. However, it was desired to introduce this condition into the experiment because nymphae normally pass the winter before obtaining their next feed.

(1) Cooley, R. A. and Kohls, G. M. Science, p. 656, 1928.

Thus, under these laboratory conditions there were recovered of ticks parasitized as larvae, 59.4 per cent and of ticks parasitized as nymphae, 80.9 per cent.

The previous paper had shown not only that the parasites will lay eggs on fed larvae, but that the resulting flat nymphae could be held for months, after which the parasites would develop if the nymphae were allowed to feed. These later results indicated that parasites in the presence of both larvae and nymphae will lay eggs in both. These findings are of much interest and may be of much practical importance. The tick passes the winter in both the nymphal and adult condition. It is possible that in a state of nature the parasites will lay eggs in both larvae and nymphae, and if so, this greatly increases our chances for the parasite to pass the winter successfully. There are involved in the problem, among other things, the following questions: (1) In this northern climate will the parasites pass the winter in sufficient numbers to maintain a progressive advance in population? (2) Will the adult parasites, in a state of nature, be abroad and ready to lay eggs when the ticks in the proper stages are available? The advantage of having the parasites lay eggs in both larvae and nymphae ticks is apparent when we remember that the flat nymphs are a normal stage for passing the winter and realize that this will insure a brood of parasites to start in their active development as soon as the parasitized flat nymphae begin to feed.

It is of much interest also to report that Mr. Morton has found that in laboratory experiments the parasites will attack the Rabbit Tick, *Haemaphysalis leporis-palustris* Pack. This is a fairly common species in Montana as well as in most of the United States. We believe this to be to our advantage for the habits of the rabbit tick are different from those of the wood tick, and the parasites will be given an added opportunity to lay eggs.

The Possibility of Transmitting Tick-Borne Diseases by Tick Parasites

Early in the work with tick parasites the possibility was foreseen that the parasites might contract the organisms of spotted fever or tularaemia and pass them on from tick to tick. The possibility is, of course, remote, but in view of its importance careful attention has been given to the point.

It is known that infected nymphs occur in nature and such nymphs run as great a chance of becoming parasitized as any others. It is of interest to know whether parasites maturing in infected nymphs are capable of transmitting a living virus to ticks that they later parasitize. The parasitized nymph will die but there exists the possibility that the parasitized nymph, if infected by the egg of the parasite, may infect the rodent before it dies from the parasite, and so pass on the disease to the rodent which, in turn might infect other ticks.

With the assistance of Doctor R. R. Parker experiments were outlined to determine if such transmission of spotted fever or tularaemia was possible, and Mr. Kohls was asked to carry out the experiments. The experiments with tularaemia have been completed and indicate clearly that there is no danger of transmitting or spreading this disease through the agency of the parasites. The experiments with spotted fever were begun in December, 1929, but they failed in each instance because of an inability at the time to get a supply of nymphae in which the infection could be positively demonstrated, and because

also of an intercurrent infection in the guinea pigs, making it impossible to reliably interpret the results. These experiments will be resumed at a latter time, and when completed will be published in detail along with those on tularaemia.

It should be added that because of the remote possibility of spreading spotted fever by the parasites, the Board of Entomology is using only such methods of parasite liberation as are absolutely safe. It is desirable to use other methods of liberation as soon as it can be demonstrated that they are equally safe.

TICK PARASITES IN AFRICA

The Secretary of the Board of Entomology went to Africa in March, 1928, for the purpose of searching for new parasites of ticks. A report on the work in Africa was prepared as far as possible immediately on returning in March, 1929, but the completion of the report has been delayed until the some 750 different lots of ticks can be identified by a specialist. The ticks were sent to a world authority on ticks but on account of the large number to be studied and because of some perplexing questions of identity which came up in the course of the studies, it has been impossible for this specialist to make his report. As soon as the identifications are received, the report on the African studies will be completed and published.

It is unwise to attempt even to summarize the results of the African venture now because the findings will be influenced by the tick identifications. We may, however, in the briefest way, state the following:

Ixodiphagus was rediscovered near Pretoria, Transvaal, and for the first time we had an opportunity to study the activities of a colony of these parasites attacking a tick *(Hyalomma aegytium* Linn.) in a state of nature. Some new facts were obtained. Some other species of ticks collected in the immediate vicinity were not parasitized.

A few days after I sailed from Durban, having completed my work in South Africa, Doctor G. A. H. Bedford, Entomologist in the Division of Veterinary Services of the Department of Agriculture, of the Union of South Africa, discovered two living specimens of a species of chalcid in a bag in which he had held a hedgehog for the purpose of feeding ticks. In a letter dated November 2, 1930, Doctor Bedford, in writing of this incident, stated:

"I found the specimens at Onderstepoort in a cage in which I had a hedgehog infested with *Haemaphysalis cooleyi*, on November 6, 1928. The cage was enclosed in a bag with a small opening at the side, and the parasites were found on the sides of the bag. At first I thought they might be parasites of a larva feeding on green forage, but when I remembered that the hedgehog was only fed on bread and milk I immediately came to the conclusion that they were probably tick parasites. The day I collected the specimens I placed them in a tube with one nymph of *H. leachi* and one engorged female of *R. evertsi*. The following day, on the 7th, one male was found dead. Each morning of the 8th, 9th and 10th, the female parasite was observed ovipositing in the female *R. evertsi*. On the 10th the parasite was transferred to another tube containing one female *O. moubata*, 3 engorged females *R. evertsi*, one engorged female *B. decoloratus* and one engorged female *A. hebraeum*. The parasite was not observed to lay eggs in any of these ticks and died on the 12th. The female *R. evertsi* in which the eggs were laid, looked very sick for a long time, but eventually recovered and laid a normal number of eggs. The other adults laid normally and showed no signs of infection. The nymph of *H. leachi* was placed on a rabbit to feed and was lost. The parasite did not appear to be at all interested in this tick."

The specimens received from Doctor Bedford were sent to Mr. A. B. Gahan, of the United States National Museum, who determined them as *Mormoniella vitripennis* (Walker). This insect is a common parasite of blowflies, which it attacks apparently in the pupa stage. It appears that the insects captured by Doctor Bedford are not a tick parasite at all, though it is difficult to explain their association with the hedgehog, and also that when the female was confined with ticks she repeatedly inserted her ovipositor in a tick.

In a letter from Doctor Bedford dated June 10, 1929, the following statement was made:

"Dr. Robinson, Cooper's Parasitologist, came out from England a short time ago and spent several days with me at Onderstepoort. He informed me that several years ago he received some engorged females of the bont tick *(Amblyomma hebraeum)* from the Cape Province, and that chalcids had hatched from some of them when he received them. He sent some of the chalcids to the British Museum to be identified, but they were unable to do so. I showed him some chalcids, and he said that they were much larger than *Ixodiphagus caucurtei* and were slightly larger than the new parasite I found, also of a different color. He has promised to send me some specimens when he returns to England. There is no use in my trying to get any specimens now as the bont tick is only found here during the summer months. In two or three months' time I will write to Veterinary Officers in the Cape and ask them to send me all the engorged females of *A. hebraeum* they can collect."

A letter was addressed to Doctor Robinson in England for the purpose of getting further information on this very important subject, and the following reply was received:

"THE COOPER TECHNICAL BUREAU
(Affiliated with Cooper, MacDonald & Robertson, Ltd.)

47, Russell Square, London, W.C.I.
11th November, 1930.

Dr. R. A. Cooley,
State of Montana Board of Entomology
Bitter Root Valley Field Station,
Bozeman, Montana. U.S.A.

Dear Sir:

I beg to acknowledge the receipt of your letter dated the 31st October, 1930.

I regret to say that I have not been able to find the single example of the fly which was derived from parasitized specimens of *Amblyomma hebraeum.* The material in question was collected at Gonubie Park, East London, South Africa, in 1909, by W. F. Cooper. The fly, a small chalcid, was sent to the British Museum (Natural History) for determination, but, to the best of my recollection was returned to Mr. Cooper with the observation that it was an undescribed species. Nothing further was done about the matter.

On making a search for the specimen of the fly, I came across a tube containing the dried and shrivelled remains of parasitized examples of *Amblyomma hebraeum* (females) which I am sending to you. If I can find the fly, I will send that to you also.

I am very sorry that I have not been able to be more helpful to you.

Yours very faithfully,

LER/KK (Signed) L. E. Robinson."

From the foregoing it appears to be clearly evident that there is a parasite of adult ticks in South Africa which attacks *Amblyomma hebraeum.* The

specimens of old dead ticks received from Doctor Robinson, along with his letter, were carefully examined in the hope that there might be found some fragments of chalcids among them, or that there might be dead specimens in some of the ticks. This search resulted in nothing of value.

While in camp some thirty miles from Pretoria, South Africa, on September 1, 1928, in examining hares which were shot after dark the day previous, a small Hymenopterous insect was seen. In opening the ear of a hare this insect ran to the edge of the ear and flew immediately. I had only a very hasty view of the insect and cannot say positively, but believe that it belonged to the family Chalcididae. The insect came from a hare which was one of two tied in a bag the night before. It undoubtedly was on one of the hares when bagged. A sketch of the insect was made from memory immediately. In the same ear was one well engorged nymph and two other partly engorged nymphae of *Hyalomma aegyptium* Linn. These ticks were kept alone and watched but no parasites developed. It should be stated, however, that if the one resulting adult tick had been allowed to feed, it is possible that parasites might have been found but I did not have the facilities for this experiment. Realizing the possible importance of the observation, a special effort was made to capture some of the same insects again. Special cages were made and laboratory rabbits were infested with ticks of a common species *(Rhipicephalus appendiculatus* Newn.) in the nymphal stage and placed one each in six cages, which were planted in the locality where the one supposed parasite specimen had been taken. These rabbits were left out and visited twice daily for three days and then taken to the laboratory in town. The ticks were recovered as they dropped but no parasites were discovered.

A SUMMARY OF PARASITE LIBERATIONS

By

GLEN M. KOHLS, *Assistant Entomologist, Montana State Board of Entomology*

This paper summarizes all liberations of the French tick parasite, *Ixodiphagus caucurtei* du Buysson, by the State Board of Entomology from 1927 to 1930, in an attempt to control the Rocky Mountain Spotted Fever tick, *Dermacentor andersoni* Stiles.

In the selection of regions for parasite liberation the Board has received aid from a number of sources. For particular assistance an expression of gratitude is due to Doctor R. R. Parker, Special Expert, U. S. Public Health Service, for his advice and counsel on various phases of the work and to Doctor A. F. Baldwin of Miles City and Doctor N. B. Smith of Billings, representatives of the State Livestock Sanitary Board, who were ready at all times to render assistance to the work in Eastern Montana in every possible way. Mr. F. A. Morton, under the direction of Professor R. A. Cooley, spent the summer months of 1929 and 1930 studying tick and rodent host populations in Eastern Montana in regard to parasite liberations and secured much information of value to the work in the future.

The methods which may be used in parasite liberation are briefly as follows:

(a) Adult parasites for liberation are reared to maturity in the laboratory. Upon emergence from the nymphs in which they developed, the parasites are collected in cotton stoppered glass tubes and transported to the field in cold thermos jars. At the site selected for planting, the parasites are released from the glass tubes, and they immediately begin to search for ticks in which to lay their eggs.

(b) Native rodents are captured in regions in which tick-borne disease is not known to exist and brought alive to the laboratory. Here they are infested with nymphal ticks. Parasites are allowed to attack the feeding ticks, and before the ticks have fed to repletion and dropped, the animals are taken to the field and liberated in the region where colonization of the parasite is desired. This method is the most "natural" means of parasite colonization, and when the areas of liberation are not too distant from the laboratory to render impractical the transport of animals, its use effects an economy in time and labor. The disadvantage of the method is the fact that all of the ticks feeding on the animals are not parasitized and killed. Some will develop into adult ticks which will be planted among the parasites. If any of the laboratory ticks are infected, this method of parasite liberation may be a means of introducing the infection in nature in regions where it had not previously existed, though the possibility is exceedingly small.

(c) Engorged nymphs containing parasites in the egg, larval or pupal stage are placed either in closed wire gauze tubes or in glass tubes open at both ends over which wire gauze is attached. The mesh in the wire gauze is large enough to permit the escape of the parasites yet retain any ticks that might have escaped parasitism. These tubes containing the parasitized nymphs

are taken to the field and placed in mice and rat runs and in and around the runs and nests of other rodents that might harbor stages of the ticks attacked by the parasite. Often times and especially when the liberations are made in mountain rat habitats, cloth or cotton is attached to the tubes to attract the animals and have them carry the tubes to their nests.

(d) In some regions, more especially in Eastern Montana, where in view of the hot dry weather parasites might fail to emerge due to desiccation of the nymphal shell of the tick, engorged nymphs are often placed in a device that maintains more than atmospheric humidity in the immediate vicinity of the nymphs. Glass tubes are drawn out so that a bore of about 1 mm. remains in one end, the other end being cotton plugged. The plugged end is inserted into a cork which is fitted on a 1"x5" shell vial filled with water. The parasitized nymphs are put into the glass tube and are thus submitted to a certain humidity as the water evaporates and passes through the chamber of the tube containing the nymphs. Parasites emerging from the nymphs escape through the small opening at the upper end of the tube.

(e) Nymphs containing parasites in the egg, larval or pupal stage are scattered broadcast around ground squirrel holes, mice holes, pack rat homes, in thickets inhabited by rabbits and other likely places where emerging parasites would have opportunity to find ticks.

Map 2 shows the general regions in which parasite plantings have been made.

For convenience in reference, parasite liberations are placed in two groups which refer roughly to the regions of liberation. Liberations that were made in the Bitter Root Valley or immediate vicinity and at Helena are termed Western Montana liberations. Those made elsewhere are termed Eastern Montana liberations. Western Montana liberations include the areas of O'Brien Creek, Lolo Canyon, Sheafman Creek, Blodgett Canyon, Roaring Lion Canyon, Lick Creek, and Lake Como on the west side of the Bitter Root Valley, Willow Creek on the east side and Helena. Eastern Montana liberations include those made at or near Bozeman, Edgar, Musselshell, Forsyth, Miles City, Jordan and Selway.

Western Montana Liberations.

O'Brien Creek Area. The O'Brien Creek area is located at the extreme north end of the Bitter Root Valley and about 5 miles southwest of Missoula. The sites of parasite liberation flank the road for a distance of about a mile beginning about a half mile from Graves' Ranch at the upper end of the road. A number of cases of spotted fever have originated in this area, and because of its proximity to a large center of population, it is desirable that parasites be colonized here as soon as possible. Parasites have been released here in considerable numbers during the past three years.

Tick Parasite Liberations—O'Brien Creek, 1928-1930

June 15, 4,000; June 29, 4,800; July 13, 9,600; October 6, 32,000	Season Total—1928	50,400
May 14, 8,098; June 4, 24,438; June 27, 22,208; July 9, 38,960; July 19, 3,440; October 16, 19,110	Season Total—1929	116,254
June 26, 46,500; October 30, 38,780	Season Total—1930	85,280
	GRAND TOTAL	251,934

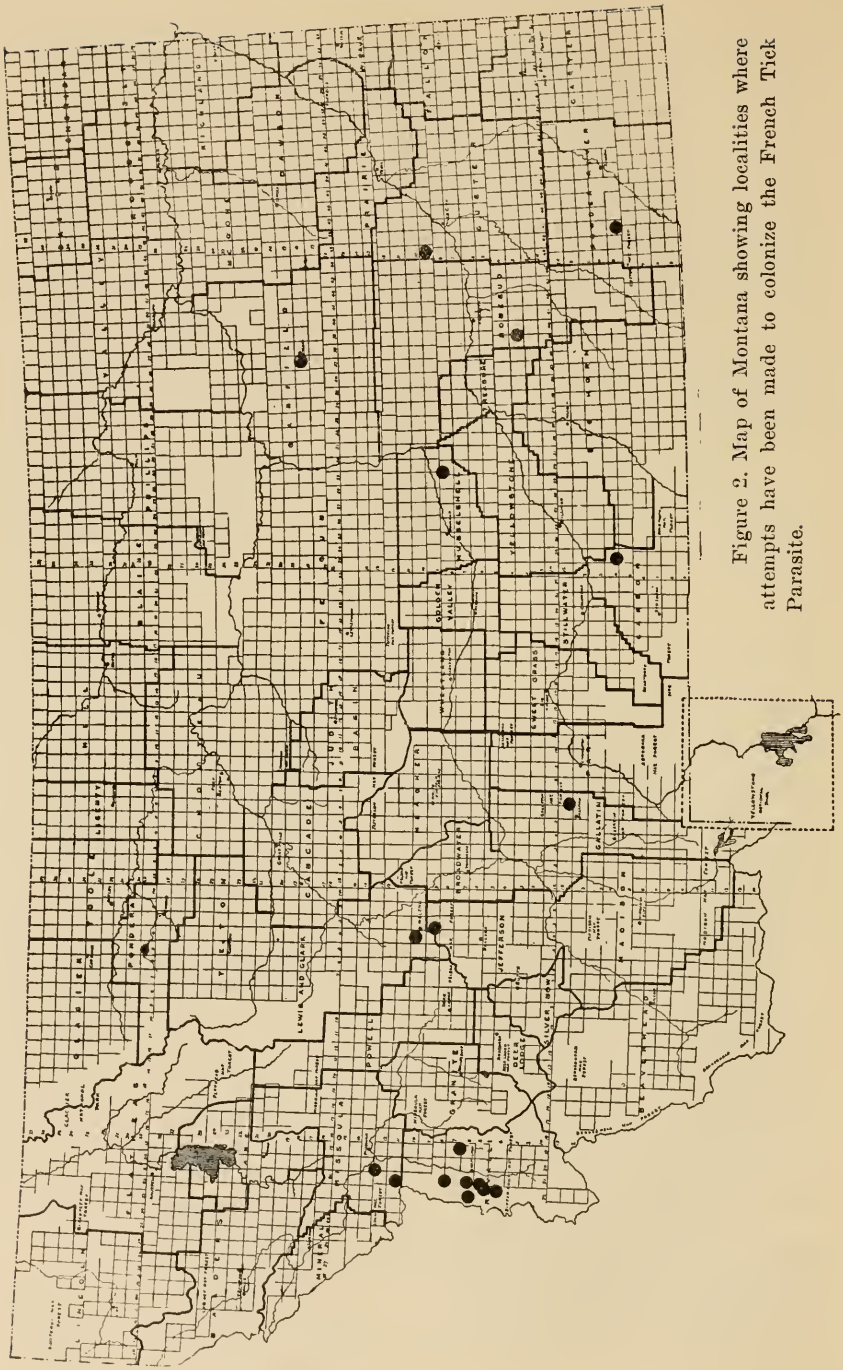


Figure 2. Map of Montana showing localities where attempts have been made to colonize the French Tick Parasite.

Lolo Canyon Area. The Lolo Canyon area is located about 15 miles west of the town of Lolo. The sites of liberation are: (1) near the junction of Bear Creek with Lolo Creek and (2) near the junction of Graves Creek with Lolo Creek. Lolo Canyon has long been known as an infected region and a number of cases of spotted fever have originated here. Although the resident population is scant, a large number of people travel through this region to Lolo Hot Springs, and if it were not for the potential danger of ticks, this section of the country undoubtedly would become a favorite recreation ground.

Tick Parasite Liberations—Lolo Canyon, 1928-1930

October 6, 30,000		
	Season Total—1928	30,000
June 4, 27,313; July 3, 12,400; October 16, 15,190		
	Season Total—1929	54,903
July 4, 19,000; October 30, 28,980		
	Season Total—1930	47,980
	GRAND TOTAL	132,883

Sheafman Creek Area. The Sheafman Creek liberation area is located four miles west and two miles north of the town of Woodside. Few ticks were found here at the time parasites were liberated. Due to the comparative inaccessibility of the area only one liberation was made.

Tick Parasite Liberation—Sheafman Creek, 1929

May 31, 13,396		
	Season and Grand Total	13,396

Blodgett Area. Blodgett Canyon opens into the valley four miles west and one mile north of Hamilton and extends west about 10 miles to summit of the Bitter Root Mountains. At a point about three miles from the divide, the Canyon widens to form a mountain meadow of approximately 10 acres in area. Here Columbian ground squirrels are found in numbers along with mice, mountain rats, chipmunks and other rodents. This isolated region with its abundant and varied rodent fauna, located in the heart of the "tick country," should prove very favorable area for parasite colonization. One liberation was made here July 11, 1930.

The region bordering the north rim of the Canyon near its mouth has been a site of parasite liberation in 1929 and 1930. Mountain goats are found here during the spring months and probably feed most of the female ticks dropped in this region. Since a comparatively high percentage of ticks originating in goat country are infected with Rocky Mountain Spotted Fever, it is desirable that parasite colonies be established in this area.

A third site of liberation is the territory in the vicinity of the mouth of the Canyon. It was here that parasites were first released in Montana in 1927. Rodent control work carried on by the Board of Entomology has so reduced the rodent population at this location that ticks are comparatively not abundant.

Tick Parasite Liberations—Blodget 1927-1930

May 1, 500; June 20, 1,000; June 28, 1,500	
Season Total—1927	3,000
May 22, 250; May 29, 2,680; July 10, 7,200; November, 32,000	
Season Total—1928	42,130
June 1, 14,575; June 8, 7,591; June 29, 18,500; Oct. 22, 14,700	
Season Total—1929	55,366
May 15, 54,200; June 10, 33,660; July 11, 50,400; Oct. 23, 40,000	
Season Total—1930	178,260
GRAND TOTAL	278,756

Roaring Lion Area. This area is located in the mouth of Roaring Lion Canyon, four miles south and three miles west of Hamilton.

Tick Parasite Liberations—Roaring Lion, 1930

June 24, 35,120; July 3, 35,000; October 28, 38,780	
Season and Grand Total	108,900

Lick Creek Area. This area is located one mile south and four miles west of the Como post office in the southern portion of the valley. It is quite isolated and possesses a ground squirrel and tick population above that of other parasite liberation areas in the Bitter Root Valley. Other rodents found in this area include pine squirrels, chipmunks, mice and mountain rats. These animals are hosts for the greater portion of the immature tick stages, while cattle, deer, elk and other large animals that frequent the salt licks provide hosts for the adult ticks. Of Western Montana areas this area is considered the most favorable for parasite colonization.

Tick Parasite Liberations—Lick Creek, 1928-1930

June 22, 2,400; July 20, 4,800; October 18, 75,000	
Season Total—1928	82,200
May 28, 10,110; June 7, 4,524; June 25, 10,300; July 16, 37,044; October 8, 14,700	
Season Total—1929	76,678
June 16, 22,000; July 19, 42,000; July 1, 28,380; July 24, 15,200; October 27, 58,000	
Season Total—1930	165,580
GRAND TOTAL	324,458

Lake Como Area. This area includes the territory immediately south of the Lick Creek area and extends to the east end of the lake. Due to the fact that the lake vicinity is becoming a favorite outing place, the eradication of the ticks, which are quite abundant, is particularly desirable. Parasite liberations were made in considerable volume in this area in 1928 and 1929. In 1930 it was felt that tick control measures affording more immediate results should be employed. Rodent poisoning work was intensified with the result that rodents became very scare, and it was deemed inadvisable to place parasites in this area this season.

Tick Parasite Liberations—Lake Como, 1928-1929

May 24, 250; June 7, 4,920; June 22, 1,600; July 6, 2,400; October 18, 25,000	
Season Total—1928	34,170
May 25, 8,477; June 7, 3,744; July 2, 23,147; July 13, 27,398; July 23, 2,491; October 8, 9,800	
Season Total—1929	75,157
GRAND TOTAL	109,327

WILLOW CREEK AREA. This area is located eight miles east and 2 miles south of Corvallis on the east side of the valley. Parasites were planted here primarily for the purpose of establishing an experimental colony for comparison with colonies on the west side of the valley.

Tick Parasite Liberations—Willow Creek, 1930

June 28, 14,400; July 16, 13,600

Season and Grand Total 28,000

HELENA AREA. Parasites have been released at three sites in the Helena area, (1) Mount Helena, (2) Nelson Gulch, located about four miles from Helena on the Priest Pass road, and (3) in the vicinity of an abandoned mine about one-half mile south of Unionville. Because this area is apparently less well adapted to colonization than certain other regions, the number of parasites released here has been somewhat restricted.

Tick Parasite Liberations—Helena Area, 1928-1930

April 30, 1,400; June 5, 710; October 3, 15,000

Season Total—1928 17,100

July 1, 3,500

Season Total—1929 3,500

June 3, 7,800; July 26, 43,960

Season Total—1930 50,760

GRAND TOTAL 71,360

Eastern Montana Liberations.

BOZEMAN AREA. This area is situated in and near the mouth of Owl Canyon, about five miles northeast of Bozeman. Ticks are usually quite abundant and from this standpoint and others, this area is a desirable one for parasite colonization. However, due to a limited supply of parasites, the distribution of parasites at this area has been very limited.

Tick Parasite Liberations—Bozeman Area, 1928

June 2, 1,120; June 9, 700; October 2, 14,000

Season and Grand Total 15,820

EDGAR AREA. This area is located in Box Canyon, about five miles east of Edgar, and is the most westerly liberation area in the sagebrush country typical of a large portion of Eastern Montana. This type of country is characterized by sagebrush covered plains or low hills cut through at intervals by shallow but abrupt canyons. The canyons are often sparsely wooded with alders and cottonwoods and are dry most of the year, but during the spring thaw or after heavy rainstorms the run-off carried by the channels may become torrential in character. Erosion is rapid, and rocks that are loosened from the sides of the canyons and rolled down form refuge for cottontail rabbits, chipmunks and mice. These animals are the principal hosts for immature stages of *D. andersoni.* The adult ticks are fed by domestic range animals and by jackrabbits. Parasites have been released in Box Canyon as shown in the following table:

Tick Parasite Liberations—Edgar Area, 1928-1930

April 22, 336; May 9, 840; May 21, 280; July 16, 644; August 20, 700; September 23, 20,000

Season Total—1928 22,800

June 6, 3,360; July 2, 5,600; September 21, 19,600

Season Total—1929 28,560

June 6, 11,000; July 3, 60,000; July 26, 10,000; Sept. 19, 7,000

Season Total—1930 88,000

GRAND TOTAL 139,360

FORSYTH AREA. This area is located in the vicinity of the Howard ranch, about 15 miles south of Forsyth. The site of liberation is around a group of abandoned farm buildings bordered by a prairie dog town on one side and by sagebrush covered prairie on the other. Ticks are not numerous here, and the value of the place as a site for parasite colonization is doubtful.

Tick Parasite Liberations—Forsyth Area, 1928-1930

May 28, 210; May 23, 280; July 16, 644; August 20, 700; September 24, 15,000	
Season Total—1928	16,834
June 6, 3,360; July 1, 3,500; September 18, 19,600	
Season Total—1929	26,460
June 9, 11,000; July 7, 33,600; July 30, 16,400; Sept. 21, 7,000	
Season Total—1930	68,000
GRAND TOTAL	111,294

MILES CITY AREA. This area is located about 18 miles northwest of Miles City, on the Sunday Creek road in typical sagebrush country. Although the tick population in the immediate vicinity of the site of parasite liberations is apparently quite scant, the area as a whole is located in a region in which ticks are quite prevalent on range stock and in which cases of spotted fever have originated.

Tick Parasite Liberations—Miles City Area, 1928-1930

April 21, 336; May 8, 420; May 23, 140; June 1, 700; June 16, 3,500; July 15, 644; August 24, 700; September 25, 18,000	
Season Total—1928	24,440
June 6, 3,360; July 4, 4,200; September 19, 19,600	
Season Total—1929	27,160
June 16, 32,000; July 10, 101,600; July 30, 17,600; September 21, 7,000	
Season Total—1930	158,200
GRAND TOTAL	209,800

SELWAY LIBERATION AREA. This area is located near Selway in the Custer National Forest. The first parasite liberation in this area was made this year at the request of residents of the district who reported the presence of ticks in considerable abundance.

Tick Parasite Liberation—Selway Area, 1930

August 14, 29,600	
Season and Grand Total—1930	29,600

JORDAN AREA. This area is located near an old shack in an uncultivated section about three miles west of Jordan. The remoteness of this area from the other sites of parasite colonization has limited parasite plantings to but one liberation made in 1928.

Tick Parasite Liberation—Jordan Area, 1928

June 2, 700	
Season and Grand Total—1928	700

MUSSELSHELL AREA. The Musselshell area represents a type of country quite different from that of other parasite liberation areas east of Bozeman. It is located in the Bull Mountains about five miles southeast of the town of Musselshell. The region is one of low hills of sandstone outcrop, eroded to form coulees, the edges of which support a conifer growth consisting chiefly of bull pine. It is in these coulees that ticks are most abundant; the

principal hosts for the immature stages being chipmunks and cottontail rabbits. Livestock and jackrabbits serve as hosts for the adult ticks. Results of field studies conducted in 1929 and 1930 indicate the superiority of this area over other liberation areas in Eastern Montana from the standpoint of parasite colonization.

Tick Parasite Liberations—Musselshell Area, 1928-1930

May 7, 420; May 22, 280; June 15, 2,700; July 4, 2,532; July 16, 644; August 15, 560; August 20, 700; September 26, 40,000	
Season Total—1928	47,836
July 6, 3,500; September 20, 39,200	
Season Total—1929	42,700
June 24, 17,200; June 25, 18,000; July 19, 18,000; July 22, 9,000; September 20, 14,000	
Season Total—1930	76,200
GRAND TOTAL	166,736

The estimated number of parasites released per year in both Western and Eastern Montana is shown below:

Year	Western Montana	Eastern Montana	Estimated Total Parasites
1927	3,000	.....	3,000
1928	238,900	145,530	384,430
1929	391,654	128,380	520,034
1930	614,000	471,760	1,085,760
GRAND TOTAL			1,993,224

During the 1929 season confined parasitized nymphs were placed in several liberation areas at the time of the parasite liberations. The confined nymphs were then examined at regular intervals throughout the summer in order to determine the progress of development and the approximate date of emergence of the parasites in the liberated material. From these observations it was learned that active engorged parasitized nymphs liberated during the 49 days from May 14 to July 2 produced adult parasites that emerged during the period of 16 days from August 13 to August 29. The number of days required for the parasites to reach maturity ranged from 91 days for the parasitized nymphs released on May 14 to 55 days for those released on July 2. These observations indicate that, because of the more rapid development at summer temperatures, parasites liberated in the egg stage in active, engorged nymphs during May, June, and the early part of July tend to attain maturity and emerge at about the same date, i.e. from the middle to the latter part of August.

Attempts to determine if the parasite has become established in nature have been made in two liberation areas: Lick Creek in 1929 and 1930 and O'Brien Creek in 1930. Due to the scarcity of nymph hosts the number of nymphs secured from the latter named area was too limited to yield data of significance.

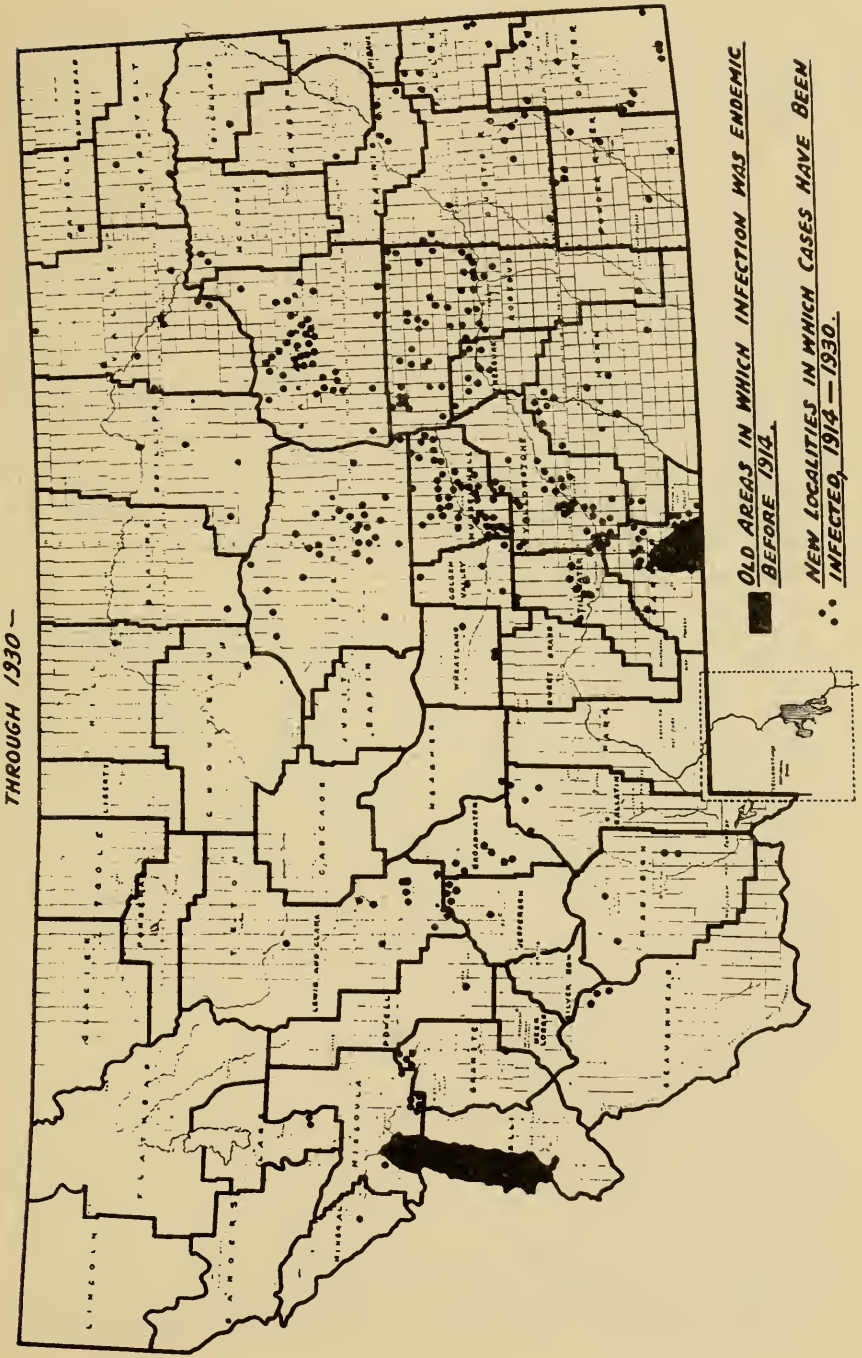
Briefly stated, the methods used in attempting to recover parasites in nature were as follows: Engorged nymphs from nature were secured by trapping rodents, principally ground squirrels, in the liberation areas and holding them alive in an improvised rearing room in the field until the ticks that

were feeding upon them when captured had completed their engorgement and dropped. Rodents were secured by trapping rather than shooting for two reasons: first, the shooting of rodents on a limited area would soon reduce their population to such an extent that they would be very difficult to secure in any number and second, the number of nymphs in the engorged state as required by the parasite for its development is small as compared to the number in the flat or partially engorged state found on the host animals at any one time. By taking the animals alive, all the ticks found on them are given an opportunity to complete their feeding, with the result that the number of fed nymphs secured from each animal is materially increased. Furthermore, after the ticks have been recovered, the animals are released back on the areas so that the rodent abundance is not materially affected.

Rodents that were released were marked with numbered leg bands to avoid their being retaken before sufficient time had elapsed to permit their becoming reinfested with ticks in nature. In order to avoid the possibility of taking nymphs that were parasitized by parasites released that season, parasite liberation was either withheld until the recovery work was completed for the season, or liberation was confined to immature parasites that would not attain maturity before that time. Engorged nymphs that were secured were taken to the laboratory where they were held at 22° C. and observed for signs of parasitism.

Parasites were first released in the Lick Creek area on June 22, 1928. Attempts to recover parasites were begun on June 7, 1929, and from that date to July 23, 1929, 250 engorged nymphs were secured from 108 ground squirrels. Upon incubation it was found that 14 of the nymphs were parasitized.

In 1930 recovery work began June 10 and was continued until July 30. A total of 139 rodents were captured yielding 209 engorged nymphs. Six ground squirrels yielding 10 nymphs were taken in the O'Brien Creek area. None of the nymphs were parasitized.


—ROCKY MOUNTAIN SPOTTED FEVER— MONTANA—
THROUGH 1930—
OLD AREAS IN WHICH INFECTION WAS ENDEMIC BEFORE 1914.
NEW LOCALITIES IN WHICH CASES HAVE BEEN INFECTED, 1914—1930.

PRESENT STATUS OF THE USE OF PUBLIC HEALTH VACCINE FOR ROCKY MOUNTAIN SPOTTED FEVER[1]

By

R. R. Parker, *Special Expert, United States Public Health Service*

The Public Health Service vaccine for the prevention of Rocky Mountain Spotted Fever has been in use for six years. A brief summary of the first four years' use was published in the Seventh Biennial Report of the Montana State Board of Entomology[2], and a more detailed account has appeared in a recent bulletin of the Hygienic Laboratory[3]. From the results of a two year test (1926 and 1927) made in southern Idaho against the mildest type of the disease and another test against the most virulent type, which had been in progress for four years in the Bitter Root Valley in western Montana, the following conclusions were expressed,—that against the milder types of infection the vaccine usually afforded full or nearly full protection, while against the highly virulent type the degree of protection was usually sufficient to cause a marked amelioration of the customary very severe symptoms and to insure the recovery of most cases.

No further test was deemed necessary so far as the mild types were concerned, but additional data seemed desirable in regard to efficacy against the virulent type. Therefore, complete record keeping in the Bitter Root Valley has been continued and will likely be extended over at least a further two years. The full six years' data for this valley (1925 to 1930) show that since the beginning of the test 3,578 persons have been vaccinated, of which nine have received vaccine 6 times, (i.e., in six different years), 64 five times, 143 four times, 257 three times, 555 twice, and 2,550 have been vaccinated once. During this test period 46 persons have become infected with the highly fatal local strains. Of these, 30 cases were in nonvaccinated persons and 16 among those vaccinated. Of the 30 nonvaccinated cases, 22 died; of the 16 vaccinated only three. The death rate in the former group was 73.33, in the latter 18.75, thus showing a marked reduction in mortality in favor of the vaccinated cases. These six years' data, and the additional opportunity which has been afforded during the past two years to observe comparatively the clinical course of infection in vaccinated and nonvaccinated persons suggest no reason to modify the conclusions previously stated regarding the value of the vaccine for use against highly virulent strains.

Only one authentic case of Rocky Mountain Spotted Fever has been reported in a vaccinated person in the much more extensive areas in which the milder types of infection predominate. This case occurred in the Idaho test area in 1927 and has been previously noted. The use of the vaccine against the milder types has become more and more widespread and the number of

(1) Contribution from the Rocky Mountain Spotted Fever Laboratory of the U. S. Public Health Service at Hamilton, Montana.
(2) Parker, R. R. Vaccination against Rocky Mountain Spotted Fever. Montana State Board Ent.; 7th Bien. Rept., pp. 68-69; Jan., 1929.
(3) Parker, R. R. and Spencer, R. R. Studies in Rocky Mountain Spotted Fever. Results of four years' human vaccination. U. S. Pub. Hlth. Serv.; Hyg. Lab. Bull. No. 154, pp. 72-103; Jan., 1930.

persons vaccinated has markedly increased each year. The total now exceeds 16,000. Full protection against mild strains may usually be expected.

The data from the Bitter Root Valley test indicate that the duration of protection in the average individual does not exceed one tick season. The period varies in individuals, however, and for some may be quite short. Vaccination each year, therefore, is desirable.

The vaccine has been employed without apparent benefit in the treatment of several of the severe Bitter Root Valley cases. Similar results have followed its experimental use in guinea pigs infected with strains from this locality. In fact, it was not certain that it was not harmful, and these observations have been interpreted as indicating that the vaccine has no therapeutic value. Its employment as a therapeutic agent, therefore, has not been recommended. In spite of this, however, a considerable number of physicians have thus used it, but particularly in sections where the milder types prevail. Some of the physicians concerned have felt that there was a quite definite favorable result, with amelioration of symptoms, shortening of the febrile period, and more rapid convalescence. Nearly all have thought that there was some beneficial effect. The number of doses, the amount, and the time at which administered have been arbitrary and variable. For the time being at least, these reports must certainly be accepted with reservation. At the same time, it should be stated that drugs which, like the vaccine, have proved valueless or even harmful when used in cases infected with Bitter Root Valley strains, have been employed with supposed good effect in milder infections, at least there have been no apparent ill effects. Therefore, it would be unwise to condemn the vaccine for therapeutic use in milder infections, because of the observations made in the Bitter Root Valley. However, the considerable range of virulence manifested by cases even in these areas of usually mild infections and the fact that recovery is usual, no matter what line of treatment is pursued, will make it exceedingly difficult to draw reliable conclusions, particularly since the actual number of cases involved is relatively small. Certainly no evidence has thus far been brought forward to justify a recommendation for its use, and it is felt that in very severe cases it might prove harmful.

On the other hand, accumulating evidence does appear to justify the statement that persons who have been tick-bitten could advisedly be vaccinated as soon thereafter as possible. In case the tick concerned is infected, the data indicates that such vaccination may result in a considerable modification and shortening of the course of infection. Physicians are therefore being advised to bear this point in mind. However, it is far more probable that vaccination when used under these circumstances will be of most value in areas where the cases are milder and the incubation period is a week or longer. There is some evidence of possible value, however, against the more virulent types.

Each year there has been an increasing demand for the vaccine and it has been necessary to increase production accordingly. The amount manufactured was doubled in 1929 and again in 1930 and it is expected that production for 1931 will increase in about the same ratio. It is now being used in all the Pacific coast and Rocky Mountain states except Arizona, and there is a moderate demand in South Dakota and Nebraska. The heaviest call is from Montana, Wyoming, Idaho, and Oregon, the last named state using the most in 1930.

The vaccine is prepared solely by the Public Health Service. It is distributed to physicians without charge and it is expected that only a nominal charge will be made for administration. Application for same should be addressed to the Officer in Charge, United States Public Health Service, Hamilton, Montana.

REVIEW OF DIPPING AND QUARANTINES

By W. J. Butler

In 1913, when the Montana State Board of Entomology was created, one of the questions that presented itself was "How are we to control the spread of spotted fever?"

The Board realized that it could not prevent or even retard the movement of wild animals and wild birds that might be carriers of one or more stages of the tick *Dermacentor andersoni* Stiles. It could, however, prevent the movement of domestic livestock out of infested areas. In order to prevent mechanical carrying of ticks by domestic livestock from dangerously infested tick areas, the Board established quarantines, restricting the movement of livestock out of infested areas during the tick season, March 1st to July 15th, unless dipped under official supervision or the ticks removed by hand picking and the animals examined and passed upon and released by an official representative of the Board of Entomology.

The Board also required in addition to rodent control by poisoning, trapping or shooting, that all domestic livestock in quarantine areas would have to be dipped in an arsenical solution under official supervision for the removal of ticks at periodical intervals. Dairy cows were exempt from this dipping provided the owners kept them free from ticks by hand picking or spraying with an arsenic pine tar solution containing 22/100 of 1% arsenic trioxide. The board also provided that a close quarantine of all domestic animals in the quarantine areas including driving horses, mules and oxen be placed upon animals and premises of all persons who refused or failed to bring their animals to the vat for dipping or who failed to remove ticks by hand picking or spraying.

Dipping vats were constructed by the Board of Entomology at strategic points in the quarantined areas. The dipping solution was made by the official representative of the Board of Entomology and was kept at proper standard by chemical tests. The board also employed men to assist in bringing in and supervising the dipping of domestic livestock in the quarantined areas.

Under the laws of Montana it was a simple matter to restrict the movement of domestic livestock out of any quarantine area. The laws of this state provide that before cattle or horses may be shipped or trailed out of a county for sale they must have a brand inspection. Brand inspectors were requested not to issue a brand certificate until the animals had been found free from ticks. A happy condition exists in the Bitter Root Valley in that the Brand Inspector is a veterinarian commissioned as a Deputy State Veterinary Surgeon and also as a representative of the Board of Entomology for the inspection of livestock going out of the quarantined areas.

I think it safely may be said that since the creation of the State Board of Entomology that there has been no movement of domestic livestock out of the Bitter Root Valley carrying infected ticks. Certainly if any domestic livestock carried ticks out of the Bitter Root Valley, it was an exception and this exception could not in any possible manner account for the wide spread of spotted fever in the State of Montana or other western states.

The dipping of domestic livestock in infested areas has a definite place in tick control. Unfortunately, dipping under Montana conditions will never eradicate the tick *Dermacentor andersoni*. Late snow storms, and inclement weather during the early spring prohibits the periodic dipping of all livestock in the infested area. Range, foothill and semi-range conditions make it impossible to gather all animals and have them at a dipping vat at a specified periodic time. However, inasmuch as rodent control cannot be successfully practiced in the foothill country where wild animal life meets with domestic animal life, it naturally follows that dipping will do more good in such districts, although the amount of good that it does in such districts is questionable. Wild life travels at night time. There are innumerable animals that cross the border line and drift into the semi-cultivated lands during the night periods carrying with them an abundance of some stage of tick life that they have picked up in the wild animal country. In these overlapping districts control of any kind, unless it be by tick parasites is difficult in the extreme.

In such districts and in the mountain fortresses of wild animal life, our main hope and in fact, the only salvation that we can see at this time in controlling tick life is by tick parasites.

That domestic livestock grazing in infested areas are a potential danger in the spread of spotted fever as well as other tick-borne diseases is manifested by the fact that during the tick season, considerable numbers of ticks are found on domestic animals in such areas. Mr. Frank O'Donnell reports that he personally removed 474 ticks from one range steer. In one bunch of ten head of cattle, he removed 1268 ticks or an average of 126.8 ticks per animal. From one horse he removed 331 adult ticks. In a band of these horses he removed 1055 ticks or an average of 175.8 ticks per annimal. Dr. H. P. Wood of the Bureau of Entomology in 1913 reports removing 212 ticks from 20 head of sheep or an average of 35.3 ticks per animal.

It is not to be presumed for one minute that every one of these ticks was an infected tick, but it is reasonable to presume that some of these ticks at least, were carriers of spotted fever or tularaemia. If the Montana State Board of Entomology had not been created and had not required the dipping or hand treating or hand picking of animals for the removal of ticks in infested areas and had not restricted the movement of domestic livestock from infested areas, it is not difficult to conceive that the spotted fever question would have been a much more serious one at the present time in Montana, as well as some of our sister states.

That there is some factor in the spread of spotted fever other than the mechanical transfer of an infected tick from one area to another by domestic livestock or wild animal life, cannot be discounted. We cannot conceive that wild animal life or domestic animal life has caused the tremendous spread of

spotted fever that has taken place in the last fifteen years. Whether spotted fever is a disease of the tick itself or an animal disease and whether or not the virulency of the virus of spotted fever is increased by climate or food, or by environment has not been determined.

We must concede that the preponderance of evidence is in favor of some such contention, nevertheless it cannot be denied that infected ticks may be carried from one area to another by wild animal life and wild bird life as well as by domestic animal life. Therefore, in the control of tick life, the destruction of rodents and the dipping or hand picking of domestic animals cannot be discounted and should not be discontinued, unless and until a tick parasite is found that will overwinter in our country and that will prove itself a natural destructive parasite to the spotted fever tick.

CONTROL WORK: ROCKY MOUNTAIN SPOTTED FEVER CONTROL DISTRICTS, BITTER ROOT VALLEY, FOR THE BIENNIUM ENDING DECEMBER 31, 1930

By

F. J. O'Donnell, *Field Agent, Montana State Board of Entomology*

During the biennium now closing, the tick control work in the Bitter Root Valley has been carried on with only minor changes in the methods adopted several years ago, as described by the writer in the Sixth Biennial Report. Previous methods were supplemented by tick dragging over a small area at the eastern end of Lake Como. Our efforts were, therefore, mainly directed toward rodent extermination and stock dipping as means of reducing the numbers of ticks.

Rodent Control: Table I summarizes the rodent control work in both Ravalli and Missoula Counties. The average cost per acre is based on the actual cost of the material used and the necessary labor required to do the field work; administrative costs are not included. Figures for 1927 and 1928 have been included for comparison. It will be noted that there was a larger area (17,454.25 acres) treated in 1929 than in 1930. This was due largely to unfavorable weather conditions in 1930. However, the total acreage for 1927-28 as compared with the total for 1929-30 shows an increase of 76,568.03 acres for the latter period, which can be also attributed to weather conditions. During the 1927-28 biennium there was considerable rainfall during the active rodent season, which prevented carrying out the full program.

STATE BOARD OF ENTOMOLOGY
SUMMARY COLUMBIAN GROUND SQUIRREL CONTROL, RAVALLI AND MISSOULA COUNTIES

Table I

Year	Poisoned Once Acres	Poisoned Twice Acres	Grain Poison Quarts	Calcium Cyanide Pounds	Labor Hours	Average Cost Per Acre for Treatment
RAVALLI COUNTY CONTROL DISTRICTS						
*1927	86,093.40	48,131.12	5,910.75	2,155.00	6,968.83	.0340
*1928	91,851.50	21,514.00	5,700.00	2,137.50	7,421.92	.0417
*1929	99,161.26	54,536.39	5,569.00	2,411.00	7,433.42	.0309
*1930	91,440.90	45,382.50	4,850.75	4,575.00	7,561.50	.0366
MISSOULA COUNTY CONTROL DISTRICTS						
1927	55,650.00	56,823.00	1,874.50	575.00	4,154.50	.0203
1928	72,310.00	51,580.00	1,898.00	309.00	4,058.50	.0177
1929	82,040.00	53,250.00	1,992.50	563.00	3,995.50	.0165
1930	85,220.00	49,490.00	1,835.00	686.00	4,085.50	.0168
U. S. Lands and National Forest						
1927	4,200.00	80.00	182.50	.....	220.66	.03108
1928	8,160.00	400.00	620.00	.....	657.83	.0481
1929	7,680.00	1,400.00	415.25	.....	214.33	.0194
1930	10,225.00	1,580.00	520.00	100.00	623.00	.0332

*U. S. Lands and National Forest Included.

The average cost of $0.0252 per acre during the last two years is somewhat lower than for the preceding two years when it was $0.0284. This decrease was effected despite the increased use of calcium cyanide, the initial cost of which is much higher than that of poisoned grain and involves an increase of about 100% in the labor charge for distribution. There was also an increase in the more intensive work in the brushy foothill areas where more time is required to locate the rodent burrows, thus incurring a higher labor charge for the acreage treated.

A considerable amount of intensive rodent extermination work was done on the National Forest reserve along the north and south shores at the eastern end of Lake Como. During the past two or three seasons this area has become quite popular as a camping grounds for fishing and picnicking parties. This was formerly a known spotted fever area, although there have been no cases reported from there in recent years. A total of 18 cases have been reported since 1893, the last case occurring in 1924. However, it was felt advisable to make an especial effort to exterminate immature tick hosts and to reduce tick infestation as much as possible. A field man was, therefore, employed to devote his entire time to rodent destruction and tick dragging in this area. Three thousand eight hundred and twenty-five acres were treated requiring 199 hours' time, 117 hours of which were employed in the distribu-

tion of both poison grain and calcium cyanide and in shooting and otherwise destroying rodents. Eighty-two hours were spent in tick dragging. All of the favorite camping sites, roads, trails and gopher colonies were dragged for ticks. Eight thousand five hundred and seventy-five adult ticks were thus collected and delivered at the laboratory. Funds permitting intensive control work will be continued in this area for at least another season.

Rodent control in both Missoula and Ravalli Counties has again been very satisfactory. A personal survey by the writer of all the districts late in May, 1929, and again early in June, 1930, showed a marked decrease in the rodent population as compared with the number of rodents noted in May and June, 1924 and 1925.

On May 22, 1924, on an inspection trip made by automobile from Hamilton to Missoula over the main west side highway, a distance of about 52 miles, at an average speed of about 30 miles per hour, 87 rodents were counted—82 ground squirrels, one rabbit and four chipmunks.

On May 29, 1930, on a trip made over the same route at approximately the same rate of speed and under similar weather conditions, only five rodents were seen—three ground squirrels and two chipmunks.

On a 22-mile auto trip and about 5 miles on foot in the Florence and Lolo districts on June 2, 1924, 107 rodents were counted—four cottontail rabbits, 12 chipmunks, two pine squirrels, eight ground hogs and 81 ground squirrels. One June 1, 1930, the same ground was covered under practically the same conditions and only two chipmunks, one pine squirrel and eight ground squirrels were seen. Inspections in other control districts have shown similar satisfactory results.

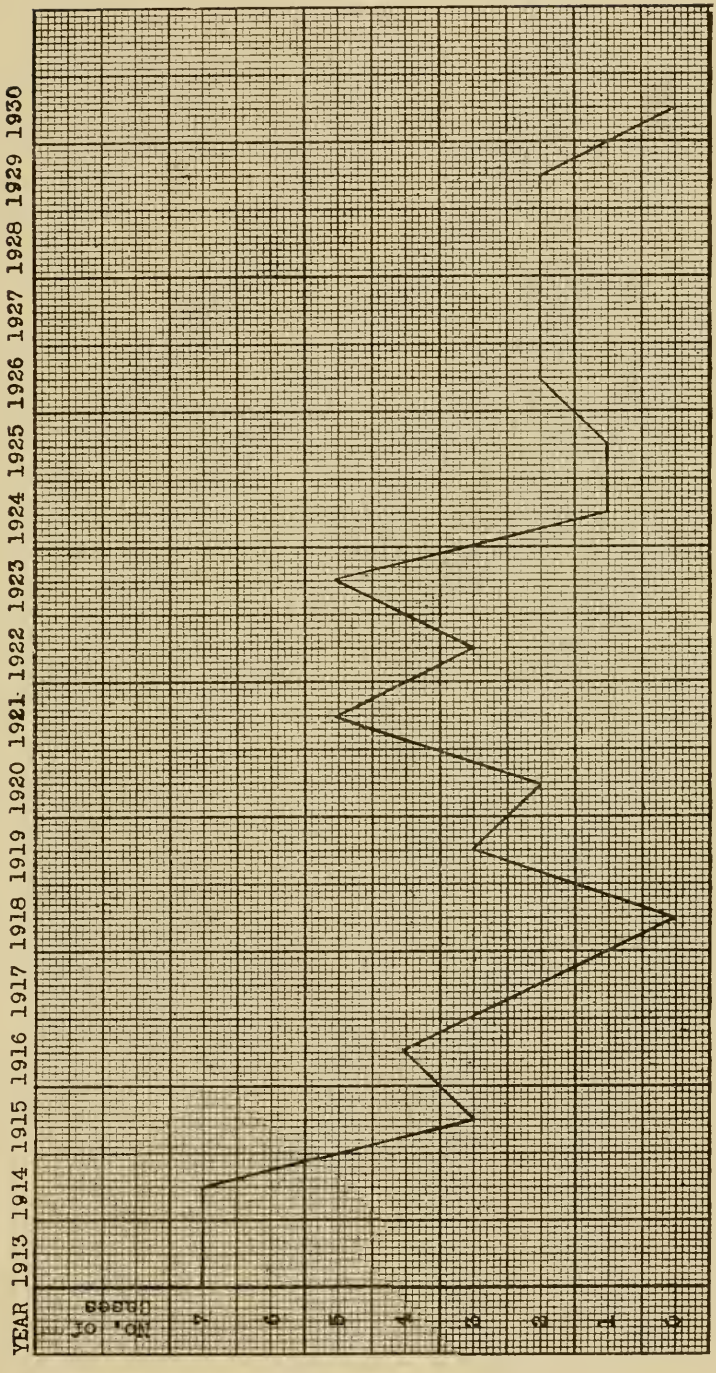
While these observations may not be an accurate index of the rodent destruction accomplished in the control districts as a whole, they do nevertheless indicate the effective results obtained by systematic and persistent rodent control work over a period of years.

As stated previously, rodent control work has been very satisfactory. This applies, however, only to valley and foothill areas where, up to the present time, the greater portion of the work has been done. It is recognized, however, that this work will have to be continued from year to year in order to maintain present conditions because of the continual inward movement of rodents, which, in the nature of the case, come principally from the mountain slopes and canyons to the west which are heavily infested with both rodents and ticks.

Until adequate funds are made available to carry on intensive control work for a number of years in the canyons and in the brushy foothill areas, in addition to a continuance of the work in the valley areas, there can be but little hope of securing permanent results in the control districts as a whole. This is one reason why effective tick parasites are so desirable.

Dipping. Stock dipping during the present biennium was somewhat more successful than during the preceding two years. A total of 2588 farm animals were dipped during 1929 and 1930 as compared with 2073 during 1927 and 1928. This number could be greatly increased if there were more vats available. This point has been frequently emphasized in previous reports. At present there are only four vats in use, one each in the Florence, Victor, Stevensville and Hamilton districts. There should be at least two vats in each of these

OCCURRENCE OF SPOTTED FEVER WITHIN THE OLDER CONTROL DISTRICTS IN RAVALLI COUNTY
1913 TO 1930 INCLUSIVE



districts as well as one in the Gold Creek district, two in the Darby district and three in the Missoula county district.

Stock dipping is a valuable accessory control measure and is popular with a large majority of the stockmen and farmers, but we cannot expect to accomplish the maximum results obtainable by this method of control until we have equipment and field crews sufficient to carry out a full and complete program.

Stock Poisoning. The loss of farm animals from rodent baits has in the past been the source of more or less friction between this office and the stock owners. Forty-one cases have been investigated during the past seven years and a settlement was made of 20 of these cases. However, with the increased use of calcium cyanide and the greater care exercised in the distribution of rodent baits, stock poisoning was entirely eliminated during the past three years.

Our relations with the County Commissioners of both Ravalli and Missoula counties have been very satisfactory. We have been given such financial assistance as we requested from them and have had their hearty support at all times.

We also wish to acknowledge the cooperation and assistance which we have received from the State Board of Health and the State Livestock Sanitary Board for the laboratory work they so kindly did for us.

The accompanying graph has been prepared to show the incidence of spotted fever in the older control districts from 1913 to 1930 inclusive. The data from which this graph was made includes only those cases which have occurred in the Florence, Stevensville, Victor, Hamilton and Gold Creek districts in Ravalli county, as the control work has been more or less continuous over this area for the past 18 years.

The average number of cases per year for the period covered by the graph is 2.83 as compared with 3.06 which was the yearly average for this area up to and including 1928. The marked decrease of spotted fever in these districts is probably due primarily to rodent destruction and the resultant and very marked decrease in tick abundance.

There are other important factors, however, which have had some influence in controlling the disease. Many of the residents in the districts have received the Spencer-Parker vaccine and also, greater care is exercised by those who have occasion to go into the tick infested areas.