THE MONTANA STATE BOARD OF ENTOMOLOGY

FIRST BIENNIAL REPORT

1913-1914

HELENA, MONTANA
DECEMBER, 1914

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INDEPENDENT PUBLISHING CO.
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MONTANA STATE BOARD OF ENTOMOLOGY.

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, Dec. 15, 1914.

To His Excellency,
Governor Samuel V. Stewart,
Helena, Montana.

My dear Sir:

I have the honor to transmit to you the First Biennial Report of the Montana State Board of Entomology.

This Board is charged with the control of insects which are carriers of disease of man and domestic animals. Two lines of work have been undertaken up to the present time, namely, the control of the Rocky Mountain Spotted fever tick and a preliminary study of the house fly and of other flies of similar habits.

It is believed that this Board has a very important place to fill in the State's service and its labors have been well begun.

Very respectfully,

R. A. COOLEY,
Secretary.

First Biennial Report of the Montana State Board of Entomology.

By R. A. Cooley.

The Montana State Board of Entomology was created by the passage of the act which follows:

Chapter 120.

"An Act to Create the State Board of Entomology. To Define its Powers and Duties and Appropriate Money Therefor."

Be it enacted by the Legislative Assembly of the State of Montana:

Section 1. There is hereby created the Montana State Board of Entomology, which shall be composed of the State Entomologist, the Secretary of the State Board of Health and the State Veterinarian.

Sec. 2. The Secretary of the State Board of Health shall be Chairman of said Board and the State Entomologist shall be Secretary.

Sec. 3. None of the members of said board shall receive any compensation other than that already allowed by law, except that the actual expenses of members while engaged in the duties incident to the work of said board shall be paid out of the appropriation made to carry on the work of said board.

Sec. 4. It shall be the duty of said board to investigate and study the dissemination by insects of diseases among persons and animals, said investigation having for its purpose the eradication and prevention of such diseases.

Sec. 5. Said Board shall take steps to eradicate and prevent the spread of Rocky Mountain tick fever, Infantile Paralysis and all other infections of communicable diseases that may be transmitted or carried by insects.

Sec. 6. Said Board shall have authority to make and prescribe rules and regulations, including the right of quarantine over persons and animals in any district of infection, and shall have the right to designate and prescribe the treatment for domestic animals to prevent the spread of such diseases; but said board shall not have the right to prescribe or regulate the treatment given to any person suffering from any infections or communicable disease.

Sec. 7. All rules and regulations of the State Board of Entomology shall be subject to approval by the State Board of Health.

Sec. 8. The Board shall publish in printed form all rules and regulations which shall be adopted by said Board for the eradication and control of diseases of any kind and such rules and regulations shall be circulated among the residents of every district affected thereby.

Sec. 9. Any person who shall violate any of the rules or regulations of the State Board of Entomology shall be deemed guilty of a misdemeanor and upon conviction thereof shall be fined in any sum not in excess of one hundred ($100.00) dollars, or by imprisonment in the county jail for any period not exceeding thirty (30) days or by both such fine and imprisonment.

Sec. 10. There is hereby appropriated out of any moneys in the State Treasury not otherwise appropriated the sum of five thousand ($5,000.00) dollars, or so much thereof as may be necessary to carry on the work of the State Board of Entomology for the year 1913, and the sum of five thousand ($5,000.00) dollars or so much thereof as may be necessary to carry on the work of said board for the year 1914. Said money to be expended under the direction and approval of the State Board of Examiners.

Sec. 11. All Acts and parts of Acts in conflict with this Act are hereby repealed.

Sec. 12. This Act shall take effect from and after its passage and approval.

Approved March 18, 1913.

FIELD OF USEFULNESS OF THIS BOARD.

The existence of the spotted fever tick and the disease which it carries in certain parts of Montana, was undoubtedly the immediate occasion for the passage of this law. There existed no service or Board in the State which was clothed with all the legal authority needed to prescribe and enforce the necessary rules and regulations for the eradication of this tick.

The progress made in recent years in the medical, veterinary and entomological sciences has emphasized the importance of insects in the transmission of human and animal dis-

eases and it was only natural and wise that Montana should provide for the investigation of disease-bearing insects within her boundaries and for the eradication or control of any which threaten the health of the people or menace the interests of the stock growers. In view of the remarkable progress in our knowledge of such matters in recent years and the various surprises that we have had, we may reasonably expect new and unforseen demands for the services of this Board. In fact there are already a number of new problems which call for attention.

SOME INSECT BORNE DISEASES.

A brief review of some of the facts concerning the part played by insects in the transmission of a few of the best known diseases will still further indicate the field of service to the State which this Board occupies.

Texas Cattle Fever and Ticks.

Among animal diseases may be mentioned Texas cattle fever which in 1893 Smith and Kilborne demonstrated to be transmitted by the cattle tick. The same investigators showed that this disease is conveyed only by this tick, there being no other means of infection of cattle. This disease is of great importance to the cattle growers of the south. It has resulted in enormous losses and large sums of money have been expended from the federal and various state treasuries in fighting it. Smith and Kilborne's work pointed out the practical method of control or eradication and excellent progress has been made during recent years by destroying the ticks.

Malaria and Mosquitoes.

In 1895 Ross watched the development of the Malarial parasite in mosquitoes that had been allowed to bite malarial patients. He also determined that this parasite can develop only in individuals of one genus of mosquitoes (Anopheles). Three years later he transmitted bird malaria from one bird to another by means of mosquitoes. Other important experiments were performed on men and it was shown that this disease is transmitted by mosquitoes and, based on good evidence, it is known that mosquitoes are the only source of infection.

It is not clear that we have had any malaria in Montana, excepting now and then a case brought in from outside, but dur-

ing recent years the State Entomologist has found malarial mosquitoes in several widely separated parts of the state which indicates the possibility of malaria being transmitted within the State.

Typhoid Fever and Flies.

It is well known that house flies, and other species of similar habits, not only breed in filth, but visit privy vaults where infected fecal matter occurs and also commonly visit public and private kitchens and eating places, thereby furnishing every opportunity for depositing germs of this disease on foods and in other situations where the germ of typhoid may find their way to the human mouth. It is not believed that flies are the only or even the principal source of infection with typhoid fever, but it is plainly indicated that under certain classes of circumstances, these insects may be of very great importance. In a State like Montana where are found many small towns which have no sewers and where open privy vaults are commonly used, the opportunities for infection by flies are greater than in older settled regions.

Tick Paralysis and the Tick.

Quite recently a new disease has become known in the Northwest, for which the spotted fever tick is also responsible. This disease is known as tick paralysis and both man and certain domestic animals are affected. The disease has attracted some attention in British Columbia and in Oregon where a considerable number of cases in man have occurred. In British Columbia sheep have also been affected. In this disease the presence of the tick attached to the body usually on the base of the head or along the spine, results in a paralysis which progresses upward, and, if the tick is not found and removed, the ending is fatal. Other animals are sometimes affected.

While no cases of tick paralysis have been officially reported, there is some evidence indicative that this disease occurs in Montana.

Some indefiniteness has surrounded this disease. The earlier reports were rather vague, but the records published by Dr. I. U. Temple, of Pendleton, Oregon, and by Dr. J. L. Todd, of McGill University, Montreal, and especially by the experi-

mental work of Dr. Seymour Hadwin, Medical Research Laboratory, Agassiz, Canada, in which he has been able to reproduce the disease through the agency of ticks, have put this new disease on a more definite basis and Dr. G. H. F. Nuttall, of England, one of the world's foremost authorities, has recently declared, "Since we have been able to reproduce tick paralysis experimentally there can be no longer any doubt as to the existence of this disease." (Parasitology, Vol. VII, No. 1, 1914, p. 102.)

Many other diseases might be mentioned in which insects play a more or less prominent part as infective agencies and this subject is looked upon as being of great importance in the prevention of disease.

SPOTTED FEVER AND THE TICK.

An abundance of evidence has shown that the common tick, called the wood-tick, is the means by which man contracts this disease. So convincing is the evidence that has been produced that it now passes as an established fact among scientists that this tick is the agency and the only one by which man becomes infected. The water transmission theory and the other theories which have had some currency are not supported by the results of investigations by scientists.

Importance of the Tick Problem in Montana.

Spotted fever is a disease of human beings and a high percentage of cases in Montana prove fatal. In laboratory experiment ground squirrels and some other rodents have been found to be susceptible to spotted fever and there are other indications that the ground squirrel at least may have the disease in nature. There can be little doubt that spotted fever germs are transmitted back and forth between ticks and some wild animals, perhaps more than one, in nature. Man contracts the disease by being bitten by one of the ticks. Until the source of infection in the tick became definitely known the disease was surrounded with an air of mystery which still continues to some extent, and which, together with the fact that the fever is so highly fatal, has lead to a somewhat general feeling of alarm. There can be no doubt that the presence of spotted fever has worked a hardship on the residents of the Bitter Root region, affecting not only the owners of property in the immediate districts, but the townspeople as well.

It is generally known throughout the United States that this disease is found in parts of Montana, but it's nature and cause are not well understood and in many instances exaggerated ideas of its prevalence and seriousness are held. It will be greatly to Montana's advantage if the actual facts may be generally made known, so that the misapprehensions may be cleared up.

In recent years the number of deaths from this disease has been around eight to twelve per year.

ERADICATION BEGUN.

In the spring of 1913, the Board of Entomology proceeded to take up the work of eradicating the spotted fever tick in the Bitter Root Valley. It was learned that both the United States Public Health Service and the Bureau of Entomology were willing to devote funds to this work and to send experts to prosecute it. In view of the magnitude of the undertaking and the limitation of the State funds at our command, it was considered wise to accept the federal aid and thus the more rapidly do away with the tick and the sooner relieve the State of this menace which costs some lives every year and injuriously affects property values in some localities.

The Bitter Root Valley, where the tick problem in Montana centers, was divided into two districts and the Public Health Service was invited to operate in the southern portion and the Bureau of Entomology in the northern portion.

These two federal services went into the field at once and have both pushed the work vigorously for the past two seasons. The State Entomologist, who serves as a member and secretary of the State Board of Entomology, was asked by the Federal Bureau of Entomology, to take local charge of the work for them in Montana. The laws of Montana direct that the Entomologist of the Experiment Station at Bozemen shall be the State Entomologist. Accordingly permission to take charge of this tick work was secured from the Director of the Experiment Station and the new duty was undertaken. This organization, however, did not relieve the Entomologist from his duties at the Experiment Station.

Dr. L. D. Fricks was detailed from the United States Public Health Service to take charge for them and he established headquarters at Victor in the southern district.

The work was carried forward under this organization during the season of 1913. It was necessary for the State Entomologist to spend a part of each week in Bozeman and a part in the northern tick district two hundred and thirty miles away, and after one year of service in this double capacity, it was decided that it was not practicable to longer perform both services. Accordingly on the opening of the season of 1914, the Bureau of Entomology placed a man in the field to devote his entire time to the work. Mr. W. V. King, a graduate in Entomology from the Montana Agricultural College, and now in the employ of the Federal Bureau of Entomology, was placed in charge. Doctor Fricks returned to take charge for the Public Health Service for the second season.

It is believed that both of these federal services will continue in this work in the future and that the State will continue to have the benefit of their assistance.

The Board of Entomology is working in co-operation with these Federal departments.

The law passed by the last legislature gave authority to prescribe and enforce such rules and regulations as are necessary in the prosecution of the work of eradication. The dipping of livestock is included in the control program and it was found necessary to place certain restrictions on the movement of animals, and the Board made and published regulations as follows:

REGULATIONS OF THE MONTANA STATE BOARD OF ENTOMOLOGY.

WHEREAS, It has been demonstrated that the common so-called wood tick of the Northwestern states, scientifically known as **Dermacentor venustus,** is the means of man's infection with the disease known as Rocky Mountain Spotted Fever, and,

WHEREAS, It is commonly known that both this tick and this disease occur on the west side of the Bitter Root Valley in the counties of Ravalli and Missoula, State of Montana, and,

Whereas, It has been shown that of the four stages in the development of this tick, the last, or adult stage, commonly occurs, and is fed on horses, mules, asses, cows and dogs.

THEREFORE, Be it resolved that the following orders and regulations be spread upon the minutes of the Montana State Board of Entomology, and communicated to the public.

Section 1.

The following tick-control districts are described and declared:

(1) The Florence District. Bounded on the east by the main channel of the Bitter Root river; on the north by the boundary between the 2nd and 3rd tiers of sections northward from the dividing line of Missoula and Ravalli counties, and extending from the river westward to and into the mountains as far as human habitations do or may go, or as far as domestic animals may wander; on the west by an imaginary line running north and south along the mountains as far back from the valley as human habitations do or may occur, or as far as domestic animals do or may wander; and on the south by the boundary line between townships nine and ten north, known as the O'Hare lane, and extending from above described imaginary line on the west, eastward to the main channel of the Bitter Root river.

(2) The Stevensville District. Bounded on the east by the main channel of the Bitter Root river; on the north by the boundary line between townships nine and ten north, extending from the main channel of the Bitter Root river to and into the mountains as far as human habitations do or may go, or do-

mestic animals do or may wander; on the west by an imaginary line running north and south along the mountains as far back from the valley as human habitations do or may occur, and as far as domestic animals do or may wander; on the south by a certain stream of water commonly known as Big Creek, extending from the mountains to the Bitter Root river.

(3) The Victor District. Bounded on the east by the main channel of the Bitter Root river, on the north by a certain stream of water known as Big Creek, extending from the Bitter Root river to and into the mountains; on the west by an imaginary line running north and south along the mountains, as far back from the valley as human habitations do or may go, or domestic animals do or may wander; on the south by the highway locally known as the Bourne lane and on the east and west extension of the same, extending from the main channel of the Bitter Root river to and into the mountains.

Section II.

At a convenient point in each tick-control district shall be constructed a dipping vat and yards, for use in dipping domestic animals, and all cows, horses, mules, asses and dogs shall be periodically dipped or otherwise freed and kept free of ticks, by spraying, carding or hand-picking, at such times and in such manner as the officers in charge of the work may prescribe.

AMENDMENT TO SECTION II. The rules and regulations of the Montana State Board of Entomology, respecting the dipping of domestic animals for the destruction of the Rocky Mountain Spotted Fever tick are hereby amended; and on and after May 20th, 1913, or until otherwise notified, dairy cows which are giving milk are exempt from dipping, provided the owners keep them free of ticks by hand-picking or spraying with an arsenic-pine-tar solution, containing .22 per cent of arsenic trioxide.

Section III.

Owners of domestic animals in tick-control districts shall be allowed to dip their animals in the State dipping vats without charge, but the responsibility of delivering the animals for dipping and of passing them through the vats, or otherwise freeing them of ticks, as prescribed by the men in charge of the vats, is placed upon the owners.

Section IV.

A close quarantine of all domestic animals, including driving horses, mules and oxen, shall be placed upon animals and premises of all persons who refuse or fail to bring their animals to the vats for dipping.

Montana State Board of Entomology,
R. A. COOLEY, Secretary.

April 5, 1914.

The rules and regulations of the Montana State Board of Entomology with respect to the eradication of the Rocky Mountain Spotted Fever tick are hereby extended and amended by the addition of the following section:

Section V.

On and after April 1, 1914, domestic animals, including cows, horses, asses, mules, sheep, goats and hogs, may be removed from the tick control districts between March first and July fifteen of each year only on written permits of the Secretary of the Board of Entomology or duly authorized representatives of the United States Bureau of Entomology or the United States Public Health Service.

Montana State Board of Entomology,
R. A. COOLEY, Secretary.

April 5, 1914.

Section 1 of the rules and regulations of the Montana State Board of Entomology with respect to the eradication of the Rocky Mountain Spotted Fever tick are hereby extended and amended by the addition of the following tick control districts:

(4) The Hamilton District. Bounded on the east by the main channel of the Bitter Root river; on the north by Bourne lane and on the east and west extension of the same; on the west by an imaginary line running north and south along the mountains, as far from the valley as human habitations do or may go and domestic animals do or may wander; on the south by a certain stream of water commonly known as Canyon creek, extending from the mountains to the Bitter Root river.

(5) The Gold Creek District. Bounded on the east by the main channel of the Bitter Root river; on the north by a certain stream of water commonly known as Canyon creek, extending from the mountains to the Bitter Root river; on the west

by an imaginary line running north and south along the mountains, as far from the valley as human habitations do or may go and domestic animals do or may wander; and on the south by Lost Horse Canyon and creek and east and west extensions of the same.

Montana State Board of Entomology,
R. A. COOLEY, Secretary.

Helena, Montana, April 5, 1914.

TO WHOM IT MAY CONCERN:

Notice is hereby given that Doctor L. D. Fricks, Victor, of the U. S. Public Health Service and Mr. W. V. King, Florence, of the U. S. Bureau of Entomology, are authorized to issue permits for the removal of domestic animals from tick control districts.

By authority of the Montana State Board of Entomology.
R. A. COOLEY, Secretary.

The Bureau of Entomology and the Public Health Service have submitted reports as follows:

WORK OF BUREAU OF ENTOMOLOGY AGAINST SPOTTED FEVER TICK IN CO-OPERATION WITH BOARD.

By W. V. King.

Organization of Work.

The spotted fever area in the Bitter Root Valley, consisting in general of the territory on the west side of the Bitter Root river and extending from south of Darby to O'Brien creek a little southwest of Missoula, a distance of some 60 or 70 miles and including Lo Lo Canyon, was, by agreement in 1913 between the State Board of Entomology, the State Board of Health, the U. S. Public Health Service and the Bureau of Entomology, divided into two control districts with Big Creek, southwest of Stevensville, the dividing line. The control work in the south end of the valley was to be under the direction of the Public Health Service and that in the north end, including Lo Lo Canyon, under the Bureau of Entomology.

In the Bureau's territory three control districts were established, for the season of 1914, the Stevensville, Florence and Woodman districts. In the Stevensville district a vat had already been constructed and in the other two, vats were erected this season. In each district a man was placed in charge of the vat, H. G. Cowan in Stevensville; G. W. Shaffer in Florence; and M. J. Stanley in Woodman; the first two of which were local men. An additional inspector was employed in the Stevensville district for part of the season.

Mr. H. P. Wood conducted the more technical part of the work, preparation of dips, and determination of effect of the solutions on animals and ticks. In addition he carried on some tick biology studies and an experiment with sheep.

Co-operation with Forest Service.

In the spring of 1914, Mr. W. W. White of the Forest Service, assigned several assistants to the task of making a type map of the west side of the valley, the determination of the proportion of the different types of land and an estimation of the cost of clearing the brush and pine lands. Maps showing in color eleven classified types of land and coming under the heads of "cultivated," "cultivable" and "non-cultivable,"

were prepared and I have been supplied with copies covering the west side from Hamilton to the Missoula-Ravalli County line. These have proven especially useful.

In this report he shows that in the area between the Bitter Root river and the forest boundary and between the forks of the Bitter Root above Darby and Lo Lo, totaling 134,077 acres, 43.6 per cent is under cultivation, an additional 31.2 per cent is cultivable and 25.2 per cent is non-cultivable.

Season's Work.

Three general classes of work were followed during the season: :(1) Educational, (2) Actual control, and (3) Biological and experimental studies.

One of the most important phases of a successful control program was, early in the work, decided to be the instruction of the ranchers and residents in the life history and nature of the tick, the proof that the tick is the conveyor of the disease, the reasons for tick destruction, the logical and scientific method of eradicating the ticks and the arguments against other methods. It was thought that the holding of public meetings in the school houses and other central points in the various districts would be the best means of disseminating this information, but upon studying various local circumstances such meetings did not seem to me to be indicated and it was hoped to accomplish the same results with the distribution of circulars, personal interviews, demonstrations at the dipping plants, etc. In the entire area there are not so many people, but that all could be seen and talked to in person by some one of the men engaged on the work and a stronger individual appeal could be made in this way than in a mass meeting. There are in each locality a few leaders who influence the attitude and sentiment of the others and the first work was to determine who these were and to make special efforts to arouse their interest and gain their co-operation.

The main points seemed to be to gain the friendship and confidence of the residents, to avoid injury to stock and other occurrences which would stir up antagonism, and to constantly emphasize the first importance of the destruction of adult ticks.

In the Stevensville and Florence districts the public attitude has been so changed that it is now seldom necessary to

argue the question as to whether ticks are or are not the transmitting agent and less frequently still to urge the desirability of tick extermination. The practicability of accomplishing such an end and the means of doing so are now the debatable points and present the real difficulties in the educational side of the work.

In Lo Lo canyon the attitude is different and here the task arises of persuading the settlers that tick destruction is desirable and that the results would repay the effort. It is hard to realize that it is necessary to argue such questions with the people most interested while every one in nearby localities considers them self-evident, and even harder to realize that persons unfamiliar except in the most superficial way with the habits of the tick will originate or accept ideas which have no support in theory or fact.

Control Work.

The "control program" may be outlined as follows:

1. **Destruction of adult ticks on domestic animals.** Based upon our findings in 1910 and 1911 the fever tick can be eradicated from the valley by preventing the engorgement of the female on domestic animals and this one method was originally recommended. Should the practical difficulties of such a program be overcome, it is still thought that it would effect control; that is, reduce the number of ticks to such an extent that it would no longer be dangerous to live and work in the valley after which the cultivable land could be developed and would produce such conditions that reinfestation would not occur. It is reasonable also to suppose that even if complete eradication were not brought about that the infection itself could not be maintained, a circumstance analagous to what occurs in yellow fever when the density of mosquitoes falls below a certain limit.

2. **Destruction of native rodents.** I consider this an important secondary means of combating the tick.

3. **Burning, Clearing and Development of Land.** Undoubtedly the cultivation of land is of the greatest importance in bringing about a permanent tick-free area. But unfortunately the burning over of uncleared land as a means of destroying ticks is practised with more enthusiasm by many of the residents than any other method. At the request of the Forest

Service and because residents are apt to neglect other precautions in favor of this we have combated the idea of burning by attempting to show the impracticability and futility of it, unless it is employed preparatory to development.

Construction of Vats. In the Stevensville district a concrete vat which was constructed in 1913 was ready for operation.

Three galvanized iron vats were built this spring by E. L. Metcalf in Missoula at a cost of $720.00 and were ready for delivery on April 13. One was installed on the Townsend ranch a mile south of Florence and one-fourth mile east of the main road, and holding and dripping pens for the stock were constructed at a cost of $392.36. It was ready for use by April 25. A second one was installed on the Lachman property, a short distance west of Woodman postoffice on the county road. The pens, etc., were completed by May 19 and total cost of installation was $321.09.

Methods and Records. In March a complete census of all domestic stock in the Stevensville, Florence and Carlton districts was taken and information recorded as to the conditions under which the animals were to be kept during the tick season, whether in stable or pasture, whether in unfenced or fenced pastures, and whether cleared or uncleared, low or high land.

Although tick activity began the first week in March, the stock was not generally turned on to the pastures until the last of April, being kept on the meadows and hay fields which are as a rule not infested. During April a man was employed to keep a watch on the stock and to determine when they were turned out and when they began picking up ticks and only a few herds were found which needed treatment before the first of May. About this time the turning out became general and soon afterward a circular notice was sent out to the stock owners setting a date for the dipping of their stock. In the majority of cases the owners, in the Stevensville district, either brought their stock or sent notice that they were picking ticks by hand. If the stock was not brought to the vat the inspector visited the ranch, examined the animals and if ticks were found another dipping date was set and the owner urged to comply.

A second card form for reporting to me the animals dipped and a third form for reporting on inspected animals were supplied to the vat tenders and inspectors. During the season

an examination of part of all of the stock on nearly every place was made and a record kept of the ticks found. Those animals which were not dipped and which were in tick country were frequently inspected. In addition, the presence of ticks on pasture lands was determined by dragging cloth flags around and stock on such lands were considered infested.

Milk cows and work horses were exempted from dipping as long as no ticks were found developing on them and for the most part this class of animals caused little trouble.

Our system of exempting work horses and milk cows and other animals which the owner preferred to pick by hand or which he thought bore no ticks increased the expense of the operation, still I believe it a necessary provision and resulted beneficially in the work. A measure requiring that all animals be presented at the vat for dipping or inspection seems unwarranted to those who have few stock or few ticks and the difficulties which would prevent the absolute enforcement of such a measure would result in less effectiveness than does the present method whereby we can determine the relative importance of different groups of animals and concentrate our efforts accordingly.

The dip decided upon for use this season is an arsenic solution, known as the "Laboratory Dip," the mixture and strength of which had been worked out by Lieut.-Colonel Watkins-Pitchford in the Union of South Africa. The formula for this consists of: 8 or 8½ pounds of arsenite of soda (80% arsenious acid); 5½ pounds soft soap; 2 gallons parrafin (kerosene); 400 (Imp.) gallons of water (480 U. S. gal.).

Stevensville District.

This district consists of the area between Big Creek on the south and the O'Hare lane on the north, approximately 15,000 acres of which about one-half is uncleared land.

The domestic animals in this district consist of 295 horses and 1,038 cattle classified as: Work horses, 188; young and range horses, 107; milk cows, 302; young and range cattle, 735. There are 56 stock owners. This gives an average of 23.8 total stock and 3.3 work horses, 1.7 others, 5.4 milk cows and 13.1 range cattle per ranch. But three men own 412 range cattle or over half of the total and excepting them leaves an average of only 6 range cattle with an average of 17.3 horses and cattle per owner.

The first dipping of the stock occurred April 5, when 9 head of range cattle were dipped, but general dipping did not commence until after the first of May. During the season 56 horses and 1,282 cattle were dipped. The usual number of dippings was three times and while the dipping interval was set for 10 days it actually ranged from 11 to 19 or 20 days. When the interval exceeded 15 days, the owner usually examined his animals between dippings.

Florence District.

This district consists of the territory between the O'Hare lane on the south to the Missoula-Ravalli county line on the north or all of township 10. The inhabitable area is approximately 13,000 acres and not over half of this is under cultivation.

The census in March showed 274 horses and 746 cattle owned by 63 farmers and classified as: Work horses, 206; other horses, 68; milk cows, 342; and range cattle, 404. Several small stock owners were missed in taking the census and two refused to give the number of stock. One of these was later obtained and the number owned by the other was estimated.

From these numbers it is seen that the total number of stock in the district is 1,040, giving an average for each ranch of 16.1. The other averages are: Work horses, 3.2; other horses, 1.; milk cows, 5.4; and range cattle, 6.4. Two hundred thirty, or over half of the range cattle are owned by 7 ranchers in herds over a dozen. The rest of the animals included under this head, averaging about 3 per ranch, are young animals and are for the most part kept with the milk herd.

At the beginning of the season the sentiment against dipping was such that most of the stock owners preferred controlling their herds in some other way than by dipping. The herd of 100 cattle were kept in the tick free bottom land until late in the season when 30 of them were turned out in tick country. One herd of 25 was taken across the river. Three herds were kept by the owners on tick free areas until after tick season. All of these animals had in previous years been pastured in the worst of the tick country.

The first dipping of animals took place on May 7 and the last on June 10. Twenty-three horses and 137 cattle were dipped during the season.

When seen in the early part of the season the stock owners while showing a disinclination to dip seemed for the most part willing to take steps against the tick by either hand-picking or by keeping the animals out of tick country. Until the first of May very little inspection work was done, but after this date it was carried on systematically and I believe from that time on very few ticks escaped, except possibly in one locality where the attitude of the residents, who are foreigners, was very unsatisfactory.

Several bunches of stock were turned out during March and early April and we were unable to keep track of these until the vat had been completed, and at that time of year a large number of ticks were picked up. John Jacobson had his herd of 28 milk cows and others running on the unfenced hills north of Bass creek from March on. Lena Hendrickson had her 8 milk cows, and Chas. Miles had 10 range cattle turned out on the hills near the old camp during April and part of March. Chas. Miles stock were hand-picked once in April and over 100 ticks were removed. It is probable that these two areas became stocked with engorged females.

Carlton District.

In the early part of the season this district, lying north of the Missoula-Ravalli county line, was looked over with a view to establishing a control district. A census covering the ranches north to McClain creek, an area of about 2,800 acres, gave the following statistics: 22 ranches, 379 horses and cattle, an average of 17.2 per ranch, which were classified as: Work horses, 90, average, 4; other horses, 23, average 1; 98 milk cows, average 4.4; and 168 range cattle, average 7.6. One hundred range cattle are owned by 3 men and these would have composed most of the animals which would have been dipped.

The feeling toward dipping aroused in the Florence district last season was reflected in this locality and in looking for a suitable vat location it was found that almost no one was willing to have it erected on his property. The chief reasons advanced for this were that ticks would be brought to their land by the stock and that the neighbors would object to having it located there. It was finally decided not to install a vat here for the following reasons; the number of animals is small, the amount of tick-infested territory was thought to be quite

limited, lack of spotted fever cases indicate that infection is not present and hearty co-operation could not be looked for.

To determine the extent of tick infestation an examination of the stock in this territory was made during May and June and the following records made: 99 horses with 279 ticks and 136 cattle with 31 ticks. These include one bunch of horses from the hills north of McClain creek and this observation showed that ticks were more widely distributed between Carlton and Lo Lo than had been previously suspected. The amount of territory and number of stock which would be included in a Carlton control district is considerably increased. The examinations took place at a time when cattle are very slightly infested.

Woodman District.

This district is thought of as including that part of Lo Lo canyon lying between Tom Magee's place, 5 miles east of Woodman and Grave creek, 10 miles west of Woodman. A census made by Mr. A. E. Seamans in 1913 shows that in this district there are 10 ranches containing a total of 125 horses and 224 cattle. To these numbers should be added the Rasmussen place with 31 cattle.

This region is in many places very heavily infected with ticks in the valley as well as on the hills on the north side of the canyon and extending back at least to the first ridge at elevations from 5,000 to 6,000 feet. Grave creek, Bear creek, and Woodman creek are often spoken of as foci of heavy infestations and it was found that the stock on the Rasmussen place on Bear creek and the Lachman place on Woodman creek were heavily infested. The residents frequently speak of the killing of stock by the ticks in early spring and it seems probable that in past years the total loss from this source has been quite heavy. They speak of finding the cattle "down with ticks," and when the ticks are removed from along the back and neck the animals quickly recover, but if left, the animal, being unable to stand, will finally die. This result is due, I believe, not to loss of blood as the ticks are never abundant, except on the back and neck, but to some effect on the nervous system owing to the site of attachment. On April 23, three yearling cattle which had been dead about two weeks were found on the Rassmussen place and their death was attributed to ticks. A large number were found still on the carcasses.

The residents all speak of the scarcity of ticks on the south side of the creek, in the bottom and on the hills, and this is probably the case for the most part. This condition is apparently due to the fact that this side is heavily timbered and consequently affords less favorable conditions for rodents and pasturage for range stock.

The vat was not ready for use until May 18, and it was not our intention to do any general dipping of stock in this district and what was done was in the way of demonstration. Several of Lachman's horses and cattle were dipped and the attention of other residents called to the fact that no injury resulted. The exaggerated reports which have reached here of the injury to stock last year caused the people to think that harm was certain to result from the dipping.

The question of how to solve the tick question in this locality is a very difficult one. The residents are for the most part slow to accept new ideas and still do not believe that the tick is the infective agent. Also it seems natural with them to oppose any solution that may be suggested. With hearty cooperation a dipping program could be conducted without much trouble, but there are circumstances which make it questionable whether such a program could be carried out so as to be successful. The mountains and canyons are steep, rough and unfenced, but afford pasturage for several miles back from the valley. Many of the horses and cattle are allowed to roam at will from the opening of spring to fall and they wander back into the mountains and are not seen for weeks at a time. This is especially true of the horses which have a tendency to feed higher than do cattle. The residents feel that it would be impossible to find them and drive them in frequently for dipping If each one took an active interest in the work, the control of of the domestic animals could be accomplished, but it seems evident that they will not.

Another point is that the stock commence picking up ticks as soon as tick activity begins, in March and sometimes the last of February. It has still to be determined whether they can be dipped at this season of year without detriment.

In this locality we are not prepared to assert that the dipping of domestic animals alone will effect eradication of the tick. Bears are fairly numerous and coyotes quite so and they are undoubtedly responsible for a considerable number of

engorged ticks. These animals are always killed when seen by the residents and I doubt, if the offer of a bounty, unless of considerable size, would hasten their destruction.

The work of tick eradication will have to cover not only the valley, but also for some distance back into the mountains.

It was decided to test the practicability of using sheep as tick collectors on the mountain sides and a band of 300 were herded near Woodman for several weeks in May and June. This experiment was preliminary in nature and gave indefinite results.

Rodent Destruction.

It was decided to do some preliminary work in the destruction of rodents by the wholesale distribution of poisoned grain. Mr. R. W. Wells was employed to carry on this work and arrived in Florence the last of March.

The first squirrels of the season were noted on March 21. By the last of the month squirrels had emerged quite abundantly in the warmer parts of the valley along the main road and toward the river, and Mr. Wells began testing the effectiveness of different poison formulae.

Commencing April 6, two small crews of men were engaged upon the distribution of poisoned grain, the method being to place one bait at the entrance of each burrow.

On April 24 it was noticed that the poison put out the day previously had hardly been touched by the squirrels and it was concluded that they had ceased taking it, preferring instead the green grass which had now gotten a good start. However, this explanation was hardly satisfactory, as earlier in the month the animals had taken the grain, even where green grass abounded and all of the animals which had been found dead from the poison had been opened and in each case the stomach was full of grass. I believe that the sudden cessation of feeding had some connection with the rutting season.

The distribution of grain was discontinued on this date, approximately one-third of the total area having been covered. This area was confined to the uncleared brush-covered foot-hills which are used as pasture lands and where tick infestation is heavy. Some poisoned grain was given out among the farmers and they used it on their own places.

In addition to the above work an area of about 800 acres northwest of Florence was selected as an experiment tract and

poison, trapping and fumigation with carbon bisulphide were all used in reducing the number of ground squirrels. It was proposed to allow horses and cattle to develop ticks in the normal way without control and to determine what effect on tick abundance could be brought about by the destruction of rodents alone. About May 20 a bunch of 20 cattle were turned in this field, but they kept wandering from here to the main road and back and as some of the neighbors made objections to this they were called to the vat and dipped on May 27. It is unlikely that any engorged ticks dropped from domestic animals in this field this season. Coyotes may have been responsible for a few.

Between April 22 and 24 a total of seven days labor was spent poisoning this area and approximately 320 acres were covered. The poison was taken quite well until the last day and even this grain was found to have been taken, in going over the land some time later.

Between April 30 and May 22 a total of 14 days labor was spent in trapping over this area with steel traps. The numbers of animals caught were as follows:

Ground squirrels	135
Weasels	2
Pine squirrels	3
Chipmunks	3
Mice	3

After completing this Mr. Wells estimated that 40 or 50 ground squirrels remained in the entire tract.

Considering the squirrels taken from the traps by coyotes and badgers, those killed by poison and those actually shot and trapped, a very low estimate of the number destroyed in this area would be 250. (The number killed by poison alone was certainly more than double this number, for the number of baits put out ran into the thousands). The data collected in 1910 and 1911 showed that an average of about 75 nymphs engorged on each ground squirrel during the season. According to this we prevented the development of some 18,750 ticks in this one area.

To test the attraction for squirrels of poisoned grain late in the season, Mr. Stanley in Woodman and Mr. Wells in Florence, distributed several hundred baits in selected areas. We were surprised and much pleased at the success of this treat-

ment as it was estimated that around 70 per cent of the squirrels were destroyed. It was concluded that poisoning at this time of the year was quite effective, but not so much so as immediately after the squirrels emerge in the spring, at which time there are fewer squirrels, fewer holes to find and less dense vegetation to hide the holes. Probably also a higher proportion of the squirrels will take the grain.

The success of the rodent work this year and the rather striking theoretical results upon the ticks, have led me to feel that it is of great importance to continue this part of the work on a larger scale next year.

A REVIEW OF ROCKY MOUNTAIN SPOTTED FEVER ERADICATIVE WORK CONDUCTED BY THE UNITED STATES PUBLIC HEALTH SERVICE IN THE BITTER ROOT VALLEY, MONTANA.

By L. D. Fricks.

The United States Public Health Service has carried on investigations of Rocky Mountain spotted fever in the Bitter Root valley since 1902, but it was not until 1911 that the Service began active eradicative work in the valley at the request of and in co-operation with the Board of Health of the State of Montana.

The eradicative measures inaugurated by Dr. McClintic for the Public Health Service in 1911 followed the recommendations made by Dr. Ricketts as a result of his brilliant investigations of Rocky Mountain spotted fever. They comprise the dipping of the domestic animals known to harbor ticks and the killing of small wild mammals. This work was begun in the infected territory west of Victor, Montana, and has been continued there along the same lines up to the present time.

In 1913 at the request of the State Board of Entomology, the eradicative work in the valley was divided between the Public Health Service and the Bureau of Entomology. Two additional dipping vats were installed in the southern half of the valley ready for operation at the beginning of the season of 1914.

There are then at present three dipping vats in the southern half of the valley located as follows:

One west of Victor, erected in 1911, one west of Hamilton, erected in 1913, and one on Gold creek erected in 1913.

The entire territory south of Big creek is divided into three districts corresponding to the three vats, and all domestic animals ranging in these districts are within easy driving distance of their respective dipping vat. Under present conditions, therefore, no additional vats are needed in the southern half of the valley.

The following brief record of operations at the different vats during the season of 1914 is given:

Victor Vat: Filled April 4th; dipping began April 15, having been delayed by cold weather, and continued until June 15th. All horses and cattle ranging over tick infested territory were regularly dipped at intervals of ten days, except at the end of the season when frequent inspections showed that they were picking up no more ticks. Total number of dipping, horses 97, cattle 417, goats 21, sheep 1,191.

Hamilton Vat: Dipping began April 15th and continued until June 1st at intervals of from ten days to two weeks, so long as animals were found to harbor ticks. Total number of animals dipped, horses 7, cattle 127, sheep 500.

Gold Creek Vat: Dipping was begun late—April 22—because the owners claimed that they had not turned their stock out, and was continued until June 1. Total number of animals dipped, horses 8, cattle 247.

This was the first season of operation in the Gold Creek district and some objections were raised by the owners to the dipping of their animals. It is expected that they will co-operate more willingly hereafter and with this end in view drastic measures were not pushed the first year.

The destruction of small wild mammals has been continued in the Victor district since 1911, by shooting, trapping, poisoning and the use of carbon bisulphide. For the past two seasons, carbon bisulphide pumps have been employed in co-operation with the land owners in the three districts.

In the Victor district, where the killing of small mammals and the dipping of domestic live stock has been carried on for four years, there has been a noticeable diminution in the number of ticks found and in the cases of Rocky Mountain spotted fever reported. In that part of the district south of Bear Creek, where the live stock has been dipped but no small animals killed there has been no appreciable diminunition in the number of ticks to be found.

The following conclusions, based on the eradicative measure employed in the southern part of the Bitter Root Valley during the past four seasons, appear to be warranted:

The dipping of domestic animals is necessary when these animals are allowed to range over tick infested territory and it should reduce the tick infestation in the vicinity of the ranches.

The dipping of domestic animals alone will not eradicate Rocky Mountain spotted fever from the Bitter Root Valley.

Many wood ticks, Dermacentor Andersoni, attach themselves around the ears and horns of cattle and are not destroyed by the ordinary dipping process.

Dipping in April, after the tick season has opened, is frequently interrupted by cold weather. The dipping solutoins used should be heated by steam, as is done for sheep, or the owners should be required by regulations to keep their live stock up until the season is well advanced.

The killing of small wild animals has not been employed as extensively as its value as a tick eradicative measure warrants.

With a view to extending our campaign against the wood ticks of the Bitter Root Valley, investigation of and experiments with sheep grazing as a tick eradicative measure were begun early in 1913, and were outlined at that time to the State Board of Entomology. Later the results were published in the Public Health Reports. These experiments were continued in 1914, by securing two bands of dry sheep and grazing them over tick infested territory in the Victor and Hamilton districts from April 15th to July 15th.

One band of 1,000 sheep was secured from Dr. G. T. McCullough, Missoula, and the other of 500 sheep through Mr. L. E. Wolgamuth, of Hamilton.

The sheep were searched frequently for ticks, and at the conclusion of the experiment were sheared, dipped and returned to the east side of the valley.

Some live ticks were found at the beginning of the experiment, but practically none at the time of shearing.

It was impossible to tell how many ticks had been engorged and fertilized on the sheep except as indicated by former experiments, but it was established that twenty-five thousand adult ticks died in the sheep's wool.

Upon the investigations and experiments so far conducted in sheep grazing as a tick eradicative measure in the Bitter Root Valley, the following conclusions have been reached:

Wood ticks, Dermacentor Andersoni, have been eradicated from parts of the east side of the Bitter Root Valley by sheep grazing alone.

The fact that they are not so eradicated from sheep ranges which differ in topography and animal distribution from the

Bitter Root valley has no bearing on our problems in the valley.

There is a zone of heavy tick and small animal infestation just outside the cultivated fields from one to two miles wide and extending practically the entire length of the west side of the Bitter Root Valley, while, generally speaking, there is a scarcity of ticks and small animals found above this belt.

Started at the base. a sufficient number of sheep can be profitably grazed over this territory to pick up practically all of the ticks and from 85 to 90 per cent of these ticks will be killed by the wool of the sheep.

By driving the sheep straight back into the mountains before the engorged fertilized females are ready to drop off for egg laying, the larvae when hatched will find few hosts for attachment and hence die.

It is believed that this procedure offers the most feasible method for the establishment in a short time—two to three years—of a tick free zone along the west side foot hills and will eliminate Rocky Mountain spotted fever from the valley proper. The grazing operations can be extended into the mountains as the conditions warrant.

Under the methods of eradication previously employed the problem of Rocky Mountain spotted fever extinction promises to drag along for years, with a considerable expenditure. thus delaying the development of the valley and demanding each season its small but certain toll of lives.

It is therefore recommended that the Montana State Board of Entomology take steps to secure the co-operation of the Forest Service and the sheep owners in and near the Bitter Root valley, and the land owners of the west side, with a view to promoting on the most extensive scale practicable, and under proper supervision, the sheep grazing industry on the west side of the Bitter Root valley.

(1) McClintic, T. B.—Investigations of and tick eradication in Rocky Mountain spotted fever. Pub. Health Rep., U. S. Public Health and Mar.-Health Serv., Wash. Govt. Print. Office, 1912, XXVII, 732-760.

(2) Fricks, L. D.—Rocky Mountain spotted fever. Pub. Health Rep., U. S. Pub. Health and Mar.-Health Serv., Wash. Govt. Print. Office, August 8, 1913, XXVIII.

Fricks, L. D.—Rocky Mountain spotted fever, Reprint No. 169, from the Pub. Health Reports, February 20, 1914.

THE HOUSE FLY.

In a newly settled state like Montana, where many new towns are springing up and where much construction work is under way, entailing the maintenance of camps for the housing and feeding of laborers and work animals, conditions are naturally such as to make the fly problem a particularly important and difficult one. The great majority of the towns have no sewer system and it would be unreasonable to require them to establish sewers in most of them. In such towns flies abound, and, on the other hand, the conditions are such as to afford many opportunities for flies to visit both contaminated materials and human habitations. It is well known that the discharges from the bodies of typhoid patients carry the germs of this disease. The flies may retain the living germs for a surprisingly long time. Levy and Kayser found them to persist in a cemented privy vault up to five months, and one author (Delaphine) states that they will survive in a privy vault for a year. A certain per cent of recovered cases of typhoid fever become chronic carriers and deposit living orpanisms with the feces. There are also large numbers of mild unrecognized cases of this disease which are a source of infection, and finally, many convalescents carry and deposit the organisms for some weeks.

The danger from the house fly and from other flies of similar habits arises from the fact that they very commonly visit human feces, entangling the infective materials on the feet and on the body and ingesting them also into the intestinal tract and then pass to our kitchens, dining rooms, restaurants, grocery stores and markets and crawl over and apply the mouth parts to the food supplies. Opportunity is thus afforded for the transfer of the germs of typhoid fever and of other disorders, such as diarrhea and dysentery, directly to the places where they are most to be feared. That flies are an important factor in the spread of these diseases cannot be doubted.

In the light of what is said above, anyone who is familiar with the condition that prevails in small towns is aware that the public is exposed to grave dangers.

The following description is made at random and does not apply to any particular town or railroad. The main street is at right angles to the railway and the business part of town is

along the main street, where a few grocery stores, markets, soft drink fountains, saloons and restaurants occur. On this street also are one or two livery stables, with vast accumulations of horse manure in the rear. Along the parallel streets and cross streets are numerous home barns with manure piles close by in the alley. Along these alleys also are privies and the houses are often poorly screened. Around the hotels and saloons the conditions are particularly noticeable. In the small hotels, such as are found in these small towns, a kitchen, a dining room and generally a saloon are found and in the rear is a privy. Screen doors are usually present and conform to the law, but the doors are opened many times a day, and the flies gain entrance.

The proprietor of the hotel, the saloon keeper, the owner of the restaurant and the residents of the town are fighting an unequal battle against the flies. Science has not yet pointed out a reasonable practical way to get rid of them. They breed principally in fermenting horse manure and it is no wonder that they swarm in these small towns. The usual "swat the fly" campaign has not amounted to much and we still have flies spreading disease and reducing the earning capacity of the people and often leading to death.

House Fly Work Undertaken.

On March 24, 1914, the Board of Entomology adopted the following resolutions:

Whereas, It is scientifically established and generally accepted that the house fly or typhoid fly, scientifically known as **Musca domestica,** is a carrier of typhoid fever, tuberculosis, infantile diarrhea and other diseases of human beings, and

Whereas, It is known that both these diseases and the house fly are found within the State of Montana, and

Whereas, We believe that much may be accomplished toward a mitigation of the above named human diseases by controlling or eradicating the house fly, therefore, be it

Resolved,

(1) That the Montana State Board of Entomology take steps to investigate and control or eradicate the house fly in Montana.

FLY INSPECTION SERVICE.

Recognizing that flies have much to do with the spread of diseases, especially those of the intestinal type, a special inspector was employed during 1914 by the Board to visit places in the State where foods are sold, stored or handled and determine their sanitary status especially with reference to the abundance of flies and the conditions which favor their multiplication. Where conditions were found to be unsanitary a clean up was ordered and subsequent visits were made to see that directions had been carried out.

Following is a detailed list of the inspections made:

Dairies	12
Hotels and Restaurants	178
Confectioneries and Bake Shops	14
Meat Markets and Slaughter Houses	74
Other Places	78
Construction Camps	111
Total	467

HOUSE FLY INVESTIGATIONS.

In accordance with the foregoing resolutions, the Secretary proceeded to secure the services of an entomologist to undertake the necessary investigations. Through Dr. H. T. Fernald of the Department of Entomology, of the Massachusetts Agricultural College, we engaged Mr. Ralph R. Parker, a graduate of the College and at present a post-graduate student, who arrived in Montana during June and continued into September, when he returned to his studies in Massachusetts. His report on the work in Montana was completed after his return to Amherst.

It is believed that excellent progress was made during the one season's work. Mr. Parker is particularly well qualified for such an investigation and a large mass of information was secured as a result of his diligence. He submitted an extensive report giving in detail the results of his studies which is too voluminous to be here printed. In its place a summary is presented as follows:

SUMMARY OF "REPORT TO THE MONTANA STATE BOARD OF ENTOMOLOGY CONCERNING FLY INVESTIGATIONS CONDUCTED IN THE YELLOWSTONE VALLEY DURING THE SUMMER OF 1914."

Ralph R. Parker, M. Sc.

This summary is a brief statement of the more important results obtained during preliminary observations and experimental research undertaken for the following purposes as set forth by Prof. R. A. Cooley, Secretary of the State Board of Entomology.

1. Determine the principal breeding places of house flies under the conditions which prevail in the smaller towns in Montana.

2. Determine what flies, other than **Musca domestica** are commonly found in such towns at such places as sewer outlets on the river banks, privy vaults, barns, residences and public eating houses.

3. Determine the seasonal history of **M. domestica** in Montana, answering such questions as, (1) When the adults first appear in the spring or early summer, (2) The dates through which flies may fairly be said to be abundant, (3) When the maximum abundance occurs, (4) When the fly season closes.

4. Get all the information possible on the extent or degree of danger of flies visiting both human excreta and human foods under conditions prevailing in Montana.

5. Make preliminary tests of substances which have elsewhere been found useful as destroyers of fly larvae.

6. Make observations of conditions in Montana which would be useful in outlining a detailed program of fly control, covering such points as means and methods of destroying waste organic matter of all sorts around residences, public eating places, markets, livery stables, and other places where organic matter accumulates.

7. Secure photographic records of existing conditions wherever possible.

8. Make complete and detailed notes of all work done and of conditions as found.

9. Preserve alcoholic and pinned speciments for future study.

Since an investigation of the latitude outlined above is a matter of several years work the specific objects of the summer field work were as now designated.

a. To determine the principal breeding places of **Musca domestica** L. and its life history under Montana conditions, ascertaining such points as during what portion of the season it is abundant and when it is present in greatest abundance; also to collect incidental data concerning individual history, habits, and natural enemies.

b. To determine what other flies than **Musca domestica** L., because of their habits, may be considered to be of actual or potential importance as causative agents of disease or as conveyors of communicable intestinal diseases; also to collect data concerning their life history and habits.

c. To determine those conditions in Montana which will be useful in outlining a program of fly control—that is, conditions which are favorable to the breeding and multiplication of flies on the one hand, and on the other, conditions which will either enhance or limit the effectiveness of control measures.

d. To conduct control experiments.

The town of Laurel was selected as headquarters for all intensive work. An old store, conveniently situated in relation to other buildings, was selected as a laboratory and fitted with apparatus from the State College at Bozeman. Facilities and equipment were not such, however, as to permit bacteriological work. A temporary breeding house and an experimental manure container for house fly work were constructed in the rear of the laboratory and late in the summer an experimentally combined maggot trap and manure box. Some phases of the work were carried on under rather unsatisfactory conditions during the first part of the summer due to the fact that certain equipment ordered from Boston and other eastern points was very late in arriving. From time to time visits were made to other towns and cities in the Yellowstone Valley—Billings, Huntley, Worden, Forsyth, Miles City, Park City, Joilet and Red Lodge. For information of a local character health officers were freely consulted. The actual field work was con-

ducted between July 1 and September 1 with the aid of Mr. T. J. Kinsella, a student from the State College. The records were put into shape and the final report written after the writer's return to pursue his work at the Entomological Laboratory of the Massachusetts Agricultural College.

At the conclusion of active operations in the field the pinned and alcoholic specimens which constituted an important part of the records of the summer investigation were deposited with Prof. R. A. Cooley.

Due to the wide range covered by the investigation and the comparatively short time that could be devoted to any one phase certain of the results should be considered as indicative rather than positive.

STATEMENT OF EXPERIMENTS, METHODS AND RESULTS.

(a)

To determine the principal breeding places of Musca domestica L., (and incidentally of other flies) and its seasonal history under Montana conditions, ascertaining such points as when it may be said to be abundant and when it is present in greatest abundance; also to collect incidental data concerning individual history, habits and natural enemies.

To determine the breeding places of the house fly (and other flies) various substances were collected and flies bred therefrom. Exhaustive investigations were impossible but a sufficient number of experiments were carried through and observations made to indicate that so far as this particular question was concerned, Montana conditions were essentially the same as in other sections where no work has been done. The materials used for breeding were human excrement and that of various domestic animals, garbage and other waste substances. For collecting these, pint and quart liquid-tight pasteboard containers were used and were found both sanitary and economical. At the laboratory the materials were placed in wooden breeding boxes which were insect and odor proof. A total of 39 experiments were performed and an accurate record kept of the number of flies of each species bred and the dates of emergence.

Due to the late date at which field operations were started and their early conclusion no personal observations were possible to indicate when this fly appears in the spring and "disappears" in the fall. At best, no arbitrary limits could have been set. To ascertain its abundance during the summer months five "stations" representing different conditions were selected and a Hodge trap placed at each five days of each week. The same bait was used throughout, collections made at the same time each day, and conditions kept as nearly the same as possible at all times. A daily record was kept not only of the members of the house fly but also of all other species captured between July 7 and August 28 and of temperature and weather conditions.

In order to determine the individual history of the house fly and to make observations on the migrating habits of the larvae a specially constructed manure cage of small mesh chicken wire was used. This was covered by a fly tight box of larger size so built as to permit access to the cage and manure within. Two experiments were conducted. Fresh manure was obtained in sufficient quantites at a local livery stable. In the first experiment the manure cage was merely blocked up from the ground, but in the second a galvanized iron maggot trap was used and observations made on natural enemies within the manure and migration habits were more closely watched.

During the last few days of the work several observations were made on the flight of flies. They were permitted to feed naturally on colored syrup placed at a privy and when afterwards captured identified by the colored contents of the abdomen. The marking of flies in this manner has certain advantages over spraying them.

Results.

Breeding Experiments. A total of 13,353 flies were bred, representing 11 families and more than 40 species. From experiments with human excrement collected in privies and out of doors, 3,862 were reared. In one instance 970 flies were bred from a single stool exposed one day in a back alley. As far as the house fly was concerned except for one specimen bred from decomposing fish and one from human excrement, all the records were from horse manure.

Seasonal History Experiments. The total catch of flies for an eight week period was 96,114, representing some 25 species; 88,245 were house flies. The other species present in greatest abundance were **Muscina stabulans** (Fall.)-3473, **Lucilla sericata** (Meig.)-1456, and **Fannia** sps 2294 (including **F. scalaris** (Fabr.) **F. canicularis** (L.) and **F.** sp.) Other families represented were the Sarcophagidae (so called flesh-flies), Ortalidae, Culicidae (mosquitoes) and Sapromyzidae.

Tabulated results indicated that house fies may be considered to be abundant until at least the first of September. They are present in greatest numbers throughout the month of August and in greatest abundance during the first week, though it is probable that there should have been but little numerical difference during the first three weeks. Their decrease was

coincident with a decrease in the weekly average temperature, but it is probable that the temperature factor was of no great value due to the manner in which the records had to be made. No relation was noted between the number captured and the kind of day.

Manure Cage Experiments. From these it was found that the minimum time required from the deposition of the egg to the emergence of the adult was 10 days. It was noted that all the larvae left the manure to pupate and were captured in the maggot trap beneath the cage (in the second experiment.). This is due in part to natural migratory habits and in part to artificial conditions. Certain beetles and beetle larvae were found associated with the house fly larvae and pupae and in one instance nearly 50 per cent of the puparia examined were found to have been destroyed by some natural enemy. Larvae were also killed in large numbers. Experiments showed, that in all probability Staphylinid beetles were the destroyers and that perhaps they play a more important part in the economy of the manure pile than has been realized. Indeed, I feel convinced that the number of adults that emerged was by no means commensurate with the great numbers of eggs laid on the manure and that larval (sometimes pupae) mortality, from predaceous enemies and undetermined causes, is high. Unfortunately it seems unlikely that these factors can be controlled.

Dispersion Experiment. While the experiment to trace the flight of flies was conducted but 3 days at the conclusion of the field work, still flies were recovered at a meat market 300 yards from the bait and at several residences at shorter distances.

Life History of Musca Domestica L. From the results noted and from other sources and experiments the probable life history of the house fly in Montana can be briefly outlined. Breeding probably begins sometime in June, possibly earlier or later, depending on the season and location within the State. The females then deposit their eggs, mainly in fresh horse manure, but sometimes in other fermenting materials and waste. As at least 95 per cent breed in horse manure we are mainly concerned with the life history of the fly in this material. The eggs are either deposited in the manure pile down to a depth of several inches or else upon the freshly dropped material within

the stable, which is later thrown out. Under summer conditions these hatch in 24 hours or less and the larvae live a more or less migratory existence in the outer portion of the manure avoiding both the light at the surface and the highly heated portions of the manure within. In from three to five days they are ready to pupate and internal stimuli cause them to seek a dry place which, as a rule, is either at the periphery of the pile or even in the ground or elsewhere beyond its limits. There are perhaps several factors determining the place of pupation as brought out in the preceeding discussion. After between four and six days spent in the puparia the adults emerge and the females are fertilized probably within a short time. Several batches of eggs are deposited at intervals (400 to 600 are estimated totals). From deposition of the eggs to emergence of adults requires at least 10 days, rarely a shorter time, and probably a day or two longer in many cases. Allowing several days more before the females deposit their eggs, two weeks should be a conservative estimate of the time required for a single generation. It would probably more often be longer than shorter. This, however, is under favorable summer conditions, and the further we go toward spring or fall the longer the developmental periods. To attempt to give the possible number of generations a season would be mere guess work. The adults are most abundant during August. They begin to disappear in the fall with the advent of cold weather, though stragglers are often seen late in the season and even on warm days during the winter. It is quite generally believed that the flies hibernate as adults, but it is possible that some pass the winter as pupae.

(b)

To determine what other flies than Musca domestica L., because of their habits, may be considered to be of actual or potential importance as transmitting agents of communicable intestinal diseases; also to collect data concerning their life history, habits, etc.

In the experiments involved in the previous section certain data belonging under this head were collected. In the experiments to determine the seasonal abundance of the house fly, a record was kept for all species captured thus indicating what other flies might be found in abundance under the same condi-

tions. From the breeding experiments those species which breed in human excrement were noted.

Other experiments and collections made solely for the above stated purpose were made. The most interesting of these was a "privy trap experiment" designed to determine what species of flies frequented excreta in privies, an important question due to the very unsatisfactory type of privy in general use. A specially constructed trap was fitted to the back of a privy having an open vault. Flies were then obliged to enter the privy by means of the open door and uncovered seats. After visiting the excreta a certain proportion attempting to leave by the opening in the rear, were captured in the trap; others, of course could leave by the same means they entered.

In another series of experiments flies were trapped in the open with human excrement as a bait to learn what species frequented excrement under outdoor conditions.

A record was also kept of flies frequenting garbage and of those captured in houses, stores, etc. From these records and the above it was possible to learn which species of Montana flies that frequent or breed in excreta and other waste also frequent residences, sources of food supplies and human foods.

Results.

Excluding Culicidae at least 50 species of flies were found which bred in or frequented human excrement in the open or in privies some almost entirely, others in greater or less abundance. Of these same species 25 were either captured in residences or were known to frequent them. Of 42 determined species and others captured on garbage, 26 also were captured or bred from human excrement and 18 known to frequent both human excrement and residences.

Records made of flies occuring in public eating houses, provision stores and saloons were made principally from examination of flies captured on sticky fly paper but to some extent from observation and traps. These were necessarily far less complete than the records given above. In public eating houses 10 species were noted, all of which frequented excreta and garbage, and 9 at least were found in houses; on sticky fly paper in saloons 7 species and others which could not be determined, all also occurred on garbage and human excrement and 6 in houses; in provision stores 13 species and others undetermined, of which 10 were known to frequent human ex-

crement, 9 garbage and 7 houses. The records are presented in this fashion to show that many of the same species are found in houses and provision stores, and on garbage and excrement, thus indicating that control measures against adults must extend beyond the limits of the houses and stores to materials which attract flies outside.

Of flies captured on garbage the house fly probably constituted 90 per cent; of those captured in the "privy trap experiment," 8.94 per cent; of those taken in the open with human excrement as a bait, 21.81 per cent. **Ravinia communis** R. Pkr., **Ravania peniculata** R. Pkr., and **Sarcophaga haemorrhoidalis** Meig. (Sarcophagidae) were bred very abundantly from human excrement and the first two species also breed in horse, cow and pig dung. They are probably primary breeders in fecal matter and while usually occurring but occasionally in houses under some condition will undoubtedly be rather plentiful. Certain writers have stated that species of this family commonly occur on human foods. As regards excreta in surface privies and in the open they may perhaps be of some service at least as far as the results of the field work indicated. Oviparous species (the members of this family are viviparous) which are more commonly found in houses and on food, are prevented from maturing by these flies.

Owing to the great attractiveness of beer for various species of excreta-frequenting flies, their presence in saloons may perhaps be of importance.

Flies of the genera **Leptocera** and **Scatopse** seem to be worthy of further investigation. Flies of certain species of both these genera, especially the former breed in and frequent human excrement in great abundance and also occur in houses. A species of **Scatopse** was found quite abundantly in houses and on several occasions noted on human foods. The only research with which the writer is acquainted dealing with flies of the genus **Leptocera** indicated that they will fly considerable distances for water and flies captured in houses were found to have their abdomens distended with fecal matter. Where water is stored in carelessly covered barrels out-of-doors it might well be infected by these flies. They are very small and screens afford no protection against them. They also breed in horse manure and other animal excrement

very abundantly. As far as horse manure is concerned if properly treated for house fly control these species would probably be controlled also.

Other species which seemed of potential importance were **Muscina stabulans** (Fall.), **Lucilia sericata** (Meig.), **Lucilia caesar** (L.), **Phormia regina** (Meig.), **Caliphora erythrocephala** Meig.), **C. coloradensis** Hough, **C.latifrons** Hough, **Fannia scalaris** (Fabr.), **F. canicularis** (L.), **Drosophila ampelophila** L., **Piophila casei** (L.) and others of less interest.

Among the diseases which it has been shown or suggested that the house fly and other Montana flies may transmit are summer diarrhoea, typhoid fever, dysentery, cholera and other intestinal infections, smallpox, measles, scarlet fever, and other exanthematous diseases, erysipelas, anthrax, glanders, and other skin infections, also gonorrheal opthalmia, diphtheria, tuberculosis, leprosy and certain diseases that are localized in certain parts of the world. At least 12 of the species dealt with have been found in various kinds of myiasis. Flies are also concerned as transmitters or causitive agents of various diseases of cattle, horses, etc.

(c)

To determine those conditions in Montana which will be useful in outlining a program of fly control—that is, conditions which are favorable to the breeding and multiplication of flies on the one hand, and on the other, conditions which will either enhance or limit the effectiveness of control measures.

Local conditions were studied as closely as possible and visits made to other towns and cities referred to in the introduction. The subject can best be treated by a consideration of factors concerned from the standpoint of town and city conditions.

Privies.

From the point of view of this investigation we are concerned with the accessibility of excreta to flies. Privies permitted this from two causes—faulty construction and carelessness of persons using them. In the strict sense of the word few privies were fly proof, nearly all permitting the entrance of flies with greater or less freedom. Privy seat covers were apparently a rarity—they were noted in but few instances—and in a fair proportion of cases there was only a crosspiece.

This, coupled with the fact that nearly one-half of privy doors are left wide open more or less habitually, gives flies practically unobstructed access to the excreta. Certain railroad privies and sometimes those at hotels in small towns were among the worst instances noted, though conditions at many ranches were no better. The conditions at saloon privies were frequently especially bad, an important consideration when we understand how abundantly flies are attracted to such vicinities by empty cases, barrels, etc. Reference has already been made to the fact that in the privy trap experiment, 9,776 were captured at a privy in one month, representing only a part of the visitors. The importance of the adoption of a sanitary and fly-proof type of privy cannot be questioned.

Excreta in the Open.

This refers to fecal matter within or near town limits. In an experiment fully described in my detailed report, 970 flies were bred from a single stool deposited in a back alley; this does not consider the number which crawl over it during 24 hours exposure. Defecations in such places are as likely as not to come from a typhoid carrier capable of expelling bacteria in the urine or feces and are always a menace. For the same reason the common practice of urinating in the rear of saloons is dangerous.

Garbage.

As fly control is a question of several factors, the problem of the care and disposal of all substances which attract flies is one of practical importance. Unprotected garbage attracts flies in great numbers to the vicinity of markets, public eating houses and residences. While I found, among the local health officers, a general appreciation of the necessity for the proper care of such materials, yet conditions were generally bad. Even in cities where garbage was collected at the public expense it was left uncovered for days at a time in receptacles scarcely worthy of the name. In some instances efforts were being made to correct these conditions.

Refuse.

By this term I refer to waste matter other than garbage, such as ashes, rubbish, street filth, etc. Horse manure properly comes under this head but is discussed separately. Suffice it to say that accumulations of this character were common in all

towns and cities and not only attracted flies but sometimes furnished breeding places. They are unsightly and encourage uncleanliness. and fly control concerns not only cleanliness within the house but environmental cleanliness as well.

Horse Manure.

As the principal breeding ground of the house fly (other flies also breed in it abundantly) horse manure deserves special attention. When we consider the thousands of flies that may breed even in a few pounds of manure, and allowing a daily average production of 15 to 25 pounds per horse, the immense number which must be breeding out daily in cities and towns where the manure is in piles and uncared for can scarcely be imagined. The city of Billings was the only place visited where any systematic attempt was made to keep flies from manure and prevent their breeding. Here a type of manure box was in use in certain parts of the city and while inefficient in some respects, yet did a certain amount of good. In some towns livery stables were required to remove their manure at short intervals but in other cases it accumulated for weeks at a time. In stables from which the manure was not cleaned out daily flies were always found breeding in the manure and around the stalls. In spite of some opinions to the contrary many corrals afforded suitable conditions for fly breeding. In many instances the presence of manure serves to attract flies to localities where they will frequent substances such as excreta in privies to a greater extent than would otherwise be the case.

Sewer Outlets.

Sewer outlets become important when the discharge is not sufficiently distant from the town limits.

(d)

Control.

Efforts to control the house fly must be directed along several lines which are designated in order of their importance.

1. To control or eliminate breeding places.
2. To keep covered and effectively dispose of substances which attract these flies such as human excrement, garbage, manure and refuse.
3. To prevent the entrance of flies into buildings.
4. To prevent the contamination of food.

5. Finally to trap, poison, or otherwise dispose of such flies as do gain admission to buildings in spite of other measures of control.

I have previously mentioned the fact that as our food supplies come to a large extent from rural or semi-rural districts, fly control outside the cities and towns is an important question. It has, however, been but little dealt with and offers distinct problems from city control. Its importance in Montana must be appreciated when we realize that there are but few sizable cities and many of the small towns approach rural conditions; its discussion in this connection, however, must await direct investigation. Furthermore, this report points out certain conditions to be controlled and results to be attained, rather than to tell how; and some of the factors to be dealt with are not for the entomologist alone.

(1) To control or Eliminate Breeding Places.

Control in Horse Manure. As probably 95 per cent of house flies breed in horse manure this becomes the first consideration in control. Absolutely effective measures demand that it be kept in proper receptacles while within town or city limits and its removal from the town or city at frequent intervals (at least during the fly season). Two important questions are, how frequent removals should be and what its ultimate disposal. As far as removal is concerned, efficiency of results demands at least twice a week at certain seasons and daily when large accumulations such as are found at livery stables are concerned. It may be possible, however, to lengthen the intervals if proper measures are taken for caring for the manure. If manure is merely to be taken a given distance from the city and dumped, this distance will depend on several factors—the treatment of the manure before removal, environmental conditions outside the city, etc. Economically it is best that the manure be put to proper use and control measures should aim to preserve its fertilizing value. In many instances Montana conditions probably prevent the sale of manure as commonly practiced in some sections of the country.

Control in Human Excrement. The importance of preventing flies from breeding in excreta and from contaminating themselves with fecal bacteria is probably universally recognized. This result must be attained by the interest of the individual in the public welfare and by properly constructed privies where

sewer connections are impossible as they will be in some sections. Some types of sanitary privies that have been advocated are not fly proof.

Control in Garbage and Refuse. By keeping garbage in closed receptacles of a proper nature and its periodical removal the breeding of flies in such material may be almost eliminated. Refuse of various kinds must also be cared for.

(2) Protection of Materials Which Attract Flies.

Under this heading I refer particularly to materials which are out-of-doors—manure, garbage and excrement in privies. Access of flies to these materials should be prevented and the odors which draw them confined as much as possible. Proper care and control of substances in which flies breed largely accomplish this purpose.

(3) To Prevent the Entrance of Flies.

This is accomplished by screening, in the main; its practical benefits are well known and need not be further discussed. Repellents are sometimes used about doors, etc.

(4) To Prevent the Contamination of Food.

Even in the best kept residences flies will gain admission and exposed foods should be protected. The question of protection, however, extends beyond the home to sources of food supply and food during its transportation. Fruit and provision stores are attractive enough to flies without baiting them with accumulations of garbage and refuse.

(5) Trapping and Killing Adults.

Scientifically, perhaps this would seem to be the least important of fly control measures, but while scientific methods will go far to eliminate the "swat-the-fly" campaign, still there will always be flies that need personal attention. Trapping, poisoning, and "swatting" may be applied as fancy or exigency dictate. In a screened house fly baits seem unsatisfactory for the most part.

Difficulties to Be Met With in Control Work.

The most important contributing factor to the ultimate success of control is the individual, for although some measures must be communal, their complete success requires the assistance of the individual. Such interest can only be created by an educational campaign to make each person appreciate that

not only are the best interests of the community involved, but that his personal well being is also concerned.

Another factor of serious import is the varied conditions to be met. Measures adapted to cities may become a burden to smaller communities and rural conditions are still another problem. Control must be upon an elastic basis such that the greatest efficiency possible will be everywhere attained and yet local condition must not be lost sight of.

Disposal of manure and garbage is a question for further investigation. Montana conditions do not seem to be adapted at present for their profitable use in most instances.

Another very pertinent question concerns the local health officers. However earnest and well intentioned they may be, how can they intelligently and efficiently carry on that part of their work which has to do with control measures unless familiar with the ins and outs of the fly problem?

An Experimental Manure Box.

The idea of destroying migrating larvae was incorporated into the construction of a manure box for experimental purposes in the hope that its use would suggest alterations and improvements eventually leading to something of practical usefulness. The results were very satisfactory as far as the work was carried

A manure box of this type possesses certain advantages over the simple box ordinarily used. It results in the self-destruction of nearly all larvae, it prevents possible larval migration from the box to hatch elsewhere as adults; it permits the advantageous use of larvicidal substances; and renders the collection of manure more than once a week unnecessary.

A structure incorporating the idea of the maggot trap could well be built within the stable structure itself insuring greater protection against flies and removing the necessity for unsightly receptacles outside. The more one considers the great adaptability of the maggot trap idea the greater seems its possibilities.

A Few General Conclusions.

1. As far as the summer's work may be taken as an indication, the possibilities for a state-wide campaign seems favorable. It will, of course, be necessary to start at the root of the fly evil (ignorance, uncleanliness, and accumulations of

waste) and build up gradually. City and town conditions are easiest dealt with and their control could be initiated during further investigations to ascertain rural problems and methods applicable to them, yet even for the former, further experimental work and a more thorough understanding of economic conditions are necessary before actual results can be attained.

2. Fly control measures are essentially sanitary measures for communal cleanliness and the public health and welfare. They are measures compelling simple cleanliness and call for no efforts on the part of the individual or community but those which common decency, self-interest and civic pride should dictate.

3. An adequate and comprehensive system for the control of the house fly will go far toward controlling other flies of actual or potential interest mentioned in the detailed report.

4. Control measures cannot be safely initiated on a large scale without a thorough appreciation of varying conditions in different communities and an elastic basis on which to work.

5. Control within the city and larger towns is communal to a greater extent than in the small town. As we go from the well organized city first to the larger town, then to the small, and finally to rural conditions control becomes less and less intensive from the community standpoint and more and more so from the standpoint of the individual.