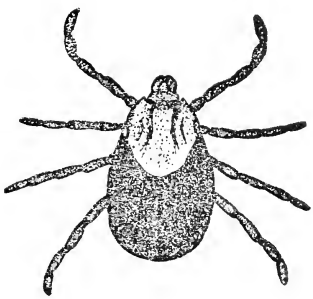
ONTANA AGRICULTURAL COLLEGE
EXPERIMENT STATION.

F. B. LINFIELD, Director.

BULLETIN No. 75.



SIXTH ANNUAL REPORT

OF THE

State Entomologist of Montana

BY
R. A. COOLEY

BOZEMAN, MONTANA

MONTANA AGRICULTURAL COLLEGE EXPERIMENT STATION.

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LETTER OF TRANSMITTAL.

Bozeman, Montana, December 15, 1908.

To His Excellency,
Governor Edwin L. Norris,
Helena, Montana.

My dear Sir:—

I have the honor to transmit herewith the Sixth Annual Report of the State Entomologist which will appear as Bulletin No. 75 of the regular series of the Experiment Station.

With much respect,

R. A. COOLEY.

FINANCIAL STATEMENT

1908			
February			
	29	E. W. Allen, trip to Yellowstone valley	$ 7.45
	29	R. A. Cooley, miscellaneous expenses	54.53
	29	R. A. Cooley, expenses	4.95
March			
	16	Bozeman Manufacturing Co., insect cabinet	72.50
	16	R. A. Cooley, trip to Missoula, Dec. 26—28	11.75
June			
	15	R. A. Cooley, trip to Helena, April 2—3	5.45
	15	R. A. Cooley, trip to Hamilton and Missoula, March 26—29	11.45
	15	R. A. Cooley, trip to Butte, May 2—3	4.50
	15	R. A. Cooley, trip to Helena and Missoula, May 6-9	19.40
July			
	20	W. A. Smith, Whitney Point, N. Y., guinea pigs	27.00
	20	Willard King, labor	35.00
	20	W. T. LeFevre, labor	13.00
	20	E. W. Allen, trip to Billings	10.80
	20	R. A. Cooley, trip to Hamilton, July 10-17	18.10
	20	R. A. Cooley, trip to Butte	7.80
October			
	19	R. A. Cooley, trip to Missoula and Corvallis, July 18—22	7.35
	19	R. A. Cooley, trip to Missoula, Aug. 28-29	10.70
	19	Owenhouse Hardware Co., sundries	3.15
	19	Owenhouse Hardware Co., sundries	1.50
	19	F. A. Maxwell, sundries	4.10
	19	Louise O'Donnell, labor	6.45
	19	E. W. Allen, labor	35.00
	19	George A. Cooley, labor	.35
	19	W. S. Haythorne, electrical supplies and labor	4.30
November			
	16	Willard King, labor	29.70

December		
21	W. J. Fransham, livery to West Gallatin canyon..	28.00
21	R. A. Cooley, trip to Butte, Nov. 14-15....	4.80
21	Herbert Gwin, labor	12.00
21	Mary L. Haskins, labor	16.10
21	E. A. Allen, labor	8.80
	Total $475.98	
	Balance to be expended by March 1st.....	24.02
	Amount unexpended last year	.33
	Amount of appropriation $500.33	

PRELIMINARY REPORT ON THE WOOD TICK

Dermacentor sp.

The admirable work of Dr. H. T. Ricketts of the University of Chicago in Missoula and the Bitter Root valley has established the fact that the wood tick found in that region is the means of man's infection with the Rocky Mountain spotted fever. He has shown:*

1. That the period of activity of the disease is limited to the season during which the adult female and male ticks attack man.

2. That in practically all cases of this disease it can be shown that the patient has been bitten by a tick.

3. That the period between the tick bite and the onset of the disease in the many animals he has experimented with corresponds very closely to this period as observed in man.

4. That infected ticks are to be found in the locality where the disease occurs.

5. That the virus of spotted fever is very intimately associated with the tissues of the tick's body as is shown by the fact that the female passes the infection on to her young through her eggs, and further, by the observation that in either of the two earlier stages of the life cycle the disease may be contracted by biting a sick animal and communicated to other animals after molting or even after passing through an intermediate active stage.

This chain of evidence, given in full in Dr. Rickett's report, is sufficient proof of the truth of the "tick theory" of the transmission of the disease.

In the public mind the question at once arises:—Since we have wood ticks in other parts of the state why do we not also have the spotted fever? The answer is that in other parts of the state the ticks do not have the infection and hence cannot transmit it. Dr. Ricketts states in his report that several hundred ticks were collected from nature in the vicinity of a case of spotted fever and were fed on normal guinea pigs and that only a small portion of them trans-

*Ricketts, H. T., Spotted Fever Report No. 1. General Report of the Investigation of Rocky Mountain Spotted Fever carried on during 1906 and 1907, published by State Board of Health, Helena, Montana.

mitted the infection. It is common knowledge in the parts of the Bitter Root valley where the disease occurs that many people are bitten with the tick who do not take this disease, showing again that only a part of the ticks are capable of giving it. Unfortunately, this fact leads some residents of the valley to give little credence to the tick theory.

Various other diseases of man and the domestic animals are known to be transmitted by ticks, mosquitoes and other insects. Notable among these are the yellow fever and malaria, both carried by mosquitoes, and the Texas fever of cattle carried by the cattle tick. The relation of these diseases to the insects and tick are well known and extensive remedial measures are based on the knowledge. There has been a marked increase in the study of mosquitoes and ticks since their importance in connection with disease has been recognized, and the results have been of great value in the saving of life and property.

Montana's spotted fever disease has been placed in the same category with these other insect-transmitted diseases, but we are woefully lacking in knowledge of the habits of the tick. This rather obscure animal has suddenly come into great prominence and our lack of knowledge regarding its habits in nature is conspicuous. Moreover, the life history of this tick must be made known before we can hope to make any progress in the eradication of the disease. The demand for this work therefore is most urgent.

So far as we have been able with the funds available we have studied ticks during the last few months. The work has been carried on both in the laboratory and in the field. For the most part the notes so far obtained in the laboratory do little more than corrobate the results published by Dr. Ricketts which constitute the most complete information regarding this tick that we possess. Some new points are indicated.

The West Gallatin trip, while developing little that is new, shows us how to proceed in the future. Without the experience of this year much less could be accomplished next season.

NOTES FROM THE INSECTARY.

A number of more or less engorged ticks were secured from horses on Sixteen Mile Creek and were placed on moist earth in

closed glass jars in May. It was hoped that from them we would get a quantity of eggs and rear a stock of ticks for future use. No records were kept of the activities of these ticks. Several thousand eggs were secured and watched for hatching. Some of the lots failed to hatch but one in particular hatched very satisfactorily on July 4th, 5th and 6th, thus furnishing a good quantity of young larval ticks.

The young ticks were observed closely in the jars and on July 9th, about four days after hatching, a few were put on guinea pigs in cages. On July 11th more larvae were put on the guinea pigs and again on July 13th. Meantime it was observed that the ticks were not attaching readily but were crawling about the cages and when put back on the guinea pigs with camel's hair brushes would crawl out to the tips of the hairs instead of inward to the skin and were often shaken or brushed off. On July 17th several hundred ticks were placed in each of four cages which contained each a single guinea pig.

The cages in which the guinea pigs were kept while the ticks were feeding were made of a three-quarter-inch frame, covered on the vertical and top sides with ordinary wire fly screening over which was placed one thickness of cotton cloth. A lid was hinged into the top and held closed by a button. The cages were twelve inches square and eight inches high. The bottom was covered with one-

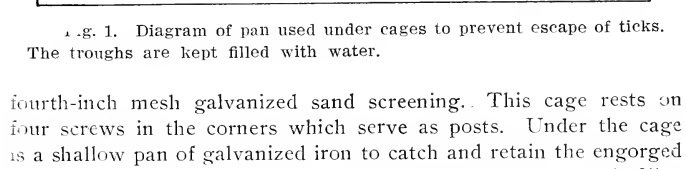

Fig. 1. Diagram of pan used under cages to prevent escape of ticks. The troughs are kept filled with water.

fourth-inch mesh galvanized sand screening. This cage rests on four screws in the corners which serve as posts. Under the cage is a shallow pan of galvanized iron to catch and retain the engorged ticks as they drop. Around the edge of this pan is a trough filled with water to prevent the ticks from crossing. The accompanying figures illustrate this cage and pan.

A small quantity of excelsior was kept under the cage in the middle of the pan to afford a means of climbing into the cage for the unfed ticks that fell into the pan. The cotton cloth covering pre-

vented the ticks from being thrown beyond the pan when the guinea pigs shook. Six of these cages were used and were found to be satisfactory. No one of the three persons who worked in the same room during the summer found any ticks on his body or clothes during the season. We used the above described cages instead of the form we had seen in use by Dr. Ricketts as we wished to closely watch the guinea pigs and ticks during the experiments. With infected ticks the form used by Dr. Ricketts would probably be more desirable.

For the sake of reducing to a minimum the amount of urine in the pans it was found to be best to feed the guinea pigs but little green food of a succulent nature. Roots and oats are more desirable than such food as dandelion leaves.

The collars used were of the sort described by Dr. Ricketts.

The following tables show the dates on which ticks were put into cages, the number put in each, with the dates, and the dates of recovery of engorged ticks.

I

CAGE 1.

Unfed larvae put in cage.	Engorged larvae recovered.
July 9—70	July 18— 2
July 17—450 (estimated.)	July 20— 4
	July 21—19
	July 22— 8
	July 23—14
	July 24— 3

II.

CAGE 2.

Unfed larvae put in cage.	Engorged larvae recovered.
July 11— 30	July 18— 1
July 13— 30	July 20—68
July 17—450 (estimated.)	July 21—75
	July 22—26
	July 23— 9
	July 24— 5

III.

CAGE 3.

Unfed larvae put in cage.	Engorged larvae recovered.
July 13— 30	July 18— 1
July 16— 30	July 20—12
July 17—450 (estimated)	July 21—85
	July 22—27
	July 23— 3

IV.

CAGE 4.

Unfed larvae put in cage.	Engorged larvae recovered.
July 13— 30	July 18— 2
July 16—30.	July 20— 3
	July 21— 0
	July 22— 0
	July 23— 2

V

CAGE 5.

Unfed larvae put in cage.	Engorged larvae recovered.
July 13— 30	July 20— 9
July 17—450 (estimated.)	July 21—13
	July 22— 1
	July 23— 1

VI.

CAGE 6.

Unfed larvae put in cage.	Engorged larvae recovered.
Aug. 5—450 (estimated)	Aug. 8— 3
	Aug.. 9— 5
	Aug. 10—54

The larvae employed in the experiments recorded in table VI were from the same general lot as those used in other cages but had been kept longer after hatching. They remained unfed for about thirty-two days and were very active when put on the guinea pig.

Five engorged ticks not recorded in these tables were recovered on July 17th from cages 2, 3, 4 and 5, in which unfed larvae had been placed on July 13th. These apparently fed for four days. From the tables above it is plainly indicated that the minimum feeding period of this stage was from three to four days. A minority dropped on the fifth, sixth and seventh days but as it had been observed that some of the ticks continued to wander about the cages after the greater number had attached we were led to believe that the last ones to drop had attached later than the others and probably dropped after a similar period of feeding.

The foregoing tables record the numbers of engorged ticks that dropped day by day without regard to the time of day that they dropped. We also kept a record of the numbers recovered in the mornings and in the afternoons. The morning records were made

from eight to nine o'clock and those in the afternoon from half past four to half past five. The records follow:

VII
CAGE 1.

Date	A.M.	P.M.
July 18	0	2
July 19	0	0
July 20	0	4
July 21	4	15
July 22	2	6
July 23	7	7

VIII.
CAGE 2.

Date	A.M.	P.M.
July 18	0	1
July 19	0	0
July 20	0	68
July 21	4	71
July 22	9	17
July 23	7	2

IX
CAGE 3.

Date	A.M.	P.M.
July 18	0	1
July 19	0	0
July 20	0	12
July 21	9	76
July 22	2	25
July 23	3	0

X
CAGE 4.

Date	A.M.	P.M.
July 18	0	2
July 19	0	0
July 20	0	3
July 21	0	0
July 22	0	0
July 23	2	0

XI.
CAGE 5.

Date	A.M.	P.M.
July 18	0	0
July 19	0	0
July 20	0	9
July 21	7	6
July 22	1	0
July 23	0	1

On July 20th, 21st, and 22nd, as the engorged ticks were being removed between eight and nine o'clock a. m., it was noticed that by going through the cages a second time immediately we could find engorged ticks that had just dropped and in such abundance that we were led to think that a part or all of those recovered a few minutes earlier had probably left the Guinea pigs within an hour or so, or since daylight. Clearly, from the records as above given, the engorged larvae preferred to drop during the daylight hours and since our morning records were taken some three or four hours after dawn, and since at about nine o'clock the ticks were known to be dropping very fast, it is not unreasonable to conclude that by far the majority dropped during the day.

We hope to settle this question beyond all doubt next season

for we feel that definite knowledge as to whether the ticks drop during the night or day may be of much value in future work.

It seems probable that it would be of value to the engorged tick to drop from the host at a time when it would be left in or near the sleeping place of the host, in order that when ready to feed again it would have a greater chance of finding a host. The adult tick in nature probably deposits on an average of about three thousand eggs and it is clear that only a very small part of the seed ticks hatching from them ever come to maturity. In fact the production of such a large number of ova is doubtless Nature's plan of off-setting the small probability that any individual will find a host. It therefore seems reasonable to conclude that since a given individual tick must find not one, but three hosts in order to come to maturity, a plan that facilitates the finding of the succession of hosts a nocturnal habit of the hosts.

A habit of dropping from the host during the day may indicate a noctural habit of the hosts.

The engorged larvae as they were recovered from the pans under the cages were placed in small pill boxes and put on a piece of sand screening over wet sand in a shallow pan. After a few days they became inactive in the manner characteristic for these animals. Under our indoor conditions the duration of this quiescent stage seems to be about two weeks. The shorter period recorded was thirteen days, and the greater number molted inside of three week. Larvae that had dropped before being fully or nearly fully engorged failed to molt into the next stage. This was also true of ticks in the quiescent stage following nymphal engorgement.

Unfed nymph ticks were put on guinea pigs in cages on August 8th, 11th and 17th respectively, from sixteen to forty-five being used. Daily records were kept of the dropping of the engorged ticks. The minimum duration of feeding was four days. In cage No. 1 it was noticed that the ticks for the most part became attached during the first day, August 8th. On August 12th two were recovered from this cage and on the following day, seven. From observations in this and other cages it was evident that the nymphal ticks remained attached for from four to seven days.

The engorged nymph ticks were placed in pill boxes over wet sand. On September 22nd those that had dropped on August 12th

molted, forty-one days having elapsed. Others molted after forty-seven days.

The adult ticks thus secured were not fed but were placed in an unheated and shaded greenhouse room for the winter.

Several hundred ticks from the same lot as those used in the cage experiments recorded above, which had not been required, were kept in the stender dish in which they hatched, for the purpose of determining how long they would live without food. The dish was sealed with vaseline and in the bottom was kept about half an inch of earth which was moistened from time to time. Left undisturbed for a few hours, the ticks gathered in clusters or "balls" but would at once scatter in all directions when the cover was lifted and would soon be seen rather evenly distributed throughout the dish. A very slight disturbance would cause them to scatter.

They lived on without noticeable change in appearance, clustering or gathering in "balls" again and again when left undisturbed. They began to die in the early part of August and by August 14th all were dead. Thus these ticks lived without food and in confinement for nearly six weeks after hatching. No green or dry vegetation was allowed in the jar. It is felt that had they been at liberty in nature their possibilities of living longer would have been much greater.

On July 29th two adult females taken from horses were received from Mr. Foley Waters who resides in the West Gallatin Basin, one being fully engorged and the other having fed but little. The smaller one was dead. The larger one was put in a small pill box and on August 4th the first eggs were found. This female continued to lay eggs until September 9th when it was thought that no more would be laid and the much shrunken female was supposed to be dead, but about a half dozen more eggs were found afterward. By actual count this female laid 4814 eggs up to September 9th, or a total of about 4820.

These eggs were placed in stender disher and on September 30th they began to hatch. Cold weather soon set in and on October 5th and 7th the dishes were placed in an enclosure on the campus where the temperature is close to that of the unprotected open. The eggs stopped hatching. On November 28th a few were brought into the building and in a few hours they had all hatched. The remainder will be kept until next spring.

These eggs were laid and the larvae were hatched at a surprisingly late date and there is good reason to think that the greater part of the remaining eggs will not hatch until early next spring.

TEMPERATURE AND HUMIDITY RECORD.*

		Temperature				Humidity	
		Out of doors		In insectary		In insectary	
	1908	Max.	Min.	Max.	Min.	Max.	Min.
July	8	87	52	85	48	76	30
	9	87	53	92	56	68	34
	10	85	52	93	58	62	33
	11	85	52	98	55	67	31
	12	89	59	91	56	58	32
	13	79	55	98	64	72	56
	14	80	58	85	60	88	41
	15	81	49	86	62	79	40
	16	72	47	88	54	83	40
	17	70	40	80	52	82	37
	18	75	48	82	46	80	37
	19	80	51	84	52	72	29
	20	82	54	89	54	73	38
	21	87	54	90	57	71	32
	22	82	53	94	57	76	40
	23	78	49	91	60	84	42
	24	83	47	88	55	79	38
	25	90	58	90	51	70	28
	26	77	47	26	97	86	35
	27	83	53	99	55	75	38
	28	84	57	92	58	70	41
	29	77	45	85	59	68	37
	30	88	49	86	50	68	37
	31	91	32	93	52	58	34
Aug.	1	94	56	94	56	62	32
	2	80	51	99	59	63	32
	3	81	44	95	59	65	29
	4	83	51	91	55	69	27
	5	84	56	91	58	59	34
	6	83	51	92	58	74	37
	7	90	49	95	55	56	33
	8	83	55	91	58	64	40
	9	87	56	91	59	62	35
	10	80	52	88	58	60	37
	11	72	52	81	57	70	50
	12	65	46	76	51	86	55
	13	52	45	57	51	86	78
	14	53	43	67	46	90	65
	15	71	46	80	51	86	42
	16	78	51	90	55	76	38
	17	81	49	91	53	80	37
	18	74	51	86	54		
	19	75	57	88	57	85	41
	20	80	47	89	52	78	41
	21	60	50	71	53	83	60
	22	75	44	82	49	88	43
	23	77	49	87	53	78	39

TEMPERATURE AND HUMIDITY RECORD.—(Continued.)

1908	Temperature				Humidity	
	Out of doors		In insectary		In insectary	
	Max.	Min.	Max.	Min.	Max.	Min.
24	82	48	85	50	87	39
25	69	46	78	50	75	44
26	71	32	81	38	78	34
27	78	39	83	44	76	27
28	69	43	78	48	75	43
29	59	34	71	44	84	42
30	50	37	62	46	89	64
31	66	35	78	40	90	41
Sept. 1	77	40	79	42	71	36
2	82	41	86	47	71	30
3	78	46	78	51	50	42
4	82	48	84	50	70	28
5	85	48	92	51	67	33
6	86	50	89	53	71	46
7	83	51	84	55	68	38
8	64	40	71	50	77	49
9	74	34	81	41	75	32
10	78	44	85	48	66	37
11	77	47	83	54	67	42
12	74	45	84	52	81	44
13	75	45	83	52	86	48
14	76	45	84	51	86	44
15	79	45	84	52	88	33
16	77	42	78	49	80	48
17	66	46	59	50	90	75
18	63	40	71	44	92	41
19	71	41	79	45	78	33
20	71	41	84	48	70	42
21	74	42	80	47	72	31
22	71	45	81	49	72	29
23	62	35	74	42	67	29
24	45	38	54	40	82	60

*Note.—The out of door temperature readings are from the official observatory records made by Professor Burke of this Experiment Station. The indoor readings are from Draper's instruments.

ACCOUNT OF TRIP INTO WEST GALLATIN CANYON TO STUDY TICKS.

The purpose of this trip was to learn as much as possible from actual observation in the field, regarding the habits and host relationships of the wood tick found in this vicinity. We desired, therefore, to shoot or capture as many as possible of the various mammals to be found in the mountains and to examine them for ticks.

I was accompanied by a junior student, Mr. Willard King. We left Bozeman Wednesday, August 12th, starting about ten o'clock a. m., and arrived and made camp at the mouth of Hell Roaring creek in the late afternoon. We remained here, shooting mammals in the vicinity, until the morning of August 15th, when we drove up the canyon as far as Swan creek, arriving there about six p. m. We drove slowly and shot animals and bagged them on the way. Our camp was made at the mouth of Swan creek and we remained there until Monday at ten a. m., when we started for home, arriving in Bozeman at seven-thirty p. m. The only unusual equipment we took with us was a supply of bags of assorted sizes in which to place the animals, singly, as we secured them, thus preventing the escape of any ticks that would detach themselves, and making it unnecessary to examine the animals as soon as shot. These bags were found to be of great service and in all future work of this sort we will continue to use them. The animals were examined in camp, where our equipment was kept and where our notes could be more perfectly taken. We found it desirable to have a supply of small traps with which to capture some of the smaller nocturnal animals. These will be added to our equipment in the future.

NUMBER AND KINDS OF ANIMALS SECURED.

The animals secured and examined were: Red or Pine Squirrel, *Sciurus hudsonicus* Erxl., 20; Chipmunk, *Tamias quadrivittatus ameonus* Allen (?), 12; Grey Ground Squirrel, *Spermophilus richardsoni* Sabine, 2; Two-Striped Squirrel, *Tamias cinerascens*

Merriam, 2; Rocky Mountain Pika, *Lagomys princeps* Richardson, 4

Besides the mammals above listed, several others were shot during the last day and were lost from the wagon while we were coming down over the rocky road of the canyon. Among these was one pika which we had observed, in picking it up, had ticks upon it. This should be added to those mentioned below.

Of the twelve chipmunks two had ticks of a species which we believe to be the same that we reared in the insectary. All of the five Rocky Mountain pikas had ticks.

It was noticeable that though we shot more red squirrels than any other animal, we found no ticks upon them, and though chipmunks were very abundant in the immediate vicinity of the series of rock slides where we secured the pikas, those obtained at this place were in every instance free from ticks, though the pikas had them in every case.

The ticks secured were in the larval and nymphal stages. Those from the chipmunks were all larvae, while those from the pikas were in both stages, even on the same animal. They were in all stages of engorgement except that none were fully fed.

We preserved the ticks alive as far as possible, and brought them to Bozeman, and on the morning following our arrival endeavored with great care to get them to attach to guinea pigs. A very few of them attached, but on the following morning those that had been attached were found in the pans beneath the cages, dead.

All of the ticks found on the chipmunks and pikas were attached in or very close to the ears.

SUMMARY.

Summarizing the foregoing, the following are indicated:

1. The larval tick does not care to feed until about a week after hatching.

2. The larvae remained attached to the host for about four days.

3. Unfed larval ticks kept in a stender dish for several weeks showed a marked tendency to gather in clusters or balls.

4. These unfed larvae died after nearly six weeks of fasting.

5. Engorged larvae showed a marked tendency to drop during the daylight hours.

6. About two weeks elapsed between the dropping of the engorged larvae and the molting to the nymph stage.

7. Nymph ticks remained attached to the host for from four to seven days.

8. Six to seven weeks elapsed between the dropping of the engorged nymph ticks and the molting to the adult stage.

9. Eggs may be laid surprisingly late in the summer.

10. The early stages of the tick occur on chipmunks and on the Rocky Mountain pika.

The following lines of work are desirable to aid in the fuller solution of the problem of the relation of the ticks to the spotted fever and their accomplishment would do much toward making known any possible remedies.

FUTURE WORK.

1. Shoot and trap as many mammals and birds as possible and examine for ticks.

2. Observe the habits and natural history of animals found to be hosts of the tick.

3. Learn as many facts as possible connected with the relation of the ticks in all stages to their host animals.

4. Learn the particular haunts and ways of the host animals.

5. Learn if the unfed ticks in the various stages are distinctly diurnal or nocturnal in habits.

6. Acquire further knowledge regarding the relation between the activities of the tick in all stages and atmospheric temperatures.

7. Prepare drawings and photographs of the external and internal structure of the tick in the various stages, particularly in the adult.

8. Gather statistical information regarding where domestic animals are pastured,—how far back into the mountain they go, etc., particularly in the vicinity of known cases of spotted fever.

9. Determine to what extent larval and nymph ticks feed on domestic animals.

10. Acquire as full knowledge as possible regarding the mammalian fauna of the west side of the Bitter Root valley.

11. Determine what other ticks are found in Montana and make an outline of their life history and host animals.

This program is incomplete and only tentative but it serves to indicate the scope of the work that is required. In order that this work may be taken up it is necessary that a moderate sum of money be appropriated. It cannot be foretold just how long it will take to secure the desired information but it is certain that more than one season will be required. The work is of such nature that it cannot be carried on in connection with other life-history studies in the insectary. It must be done mostly away from agricultural fields. For this reason it will be necessary to employ a man to devote his entire time to this work for the greater part of the year, until it is either completed or carried to such a point that the desired practical ends are secured.

It is earnestly hoped that the next legislative assembly will recognize the great importance of this as a state problem and increase the State Entomologist's appropriation, thereby making it possible to undertake its solution.

It is further hoped that the game laws may be so revised as to make it lawful for the State Entomologist and his assistants to shoot animals in Montana for these scientific purposes.

December 8, 1908.

GLOVER'S SILK MOTH

Samia gloveri Strecker.

This is one of the most attractive and wonderful insects in Montana. Nothing can be more beautiful than the newly emerged moth which, with one exception, is the largest in the state; the larva is likewise a most striking object and always attracts attention when found. It is not surprising then that specimens are frequently sent to the Experiment Station by persons who have been surprised and delighted to learn that such "rare" specimens exist.

So often has this insect been sent in, either in the larval or adult stage, that it seems desirable at this time to publish the following brief account.

I take pleasure in calling attention to the excellent photographs of the full-grown larva, the cocoon, and the adult male moth, accompanying. They were taken by Messrs. W. S. and A. F. Berry of Gardiner, Montana. These gentlemen have experienced great pleasure in watching this insect pass through its transformation and have acquired a new interest in other insects.

Glover's silk moth is not to be looked on as a pest of much importance. It has been reported to us as feeding on currant and gooseberry, but a series of larvae which we fed through to maturity in the college insectary refused to eat these plants, and a few died rather than eat, while all in the cage had a shrunken appearance. Willow and maple were eaten freely. The Messrs. Berry fed their specimens on willow.

This insect, in common with the related species, spends the winter in the cocoon which is of a strong, papery texture, being woven from the silk produced by the larva. It is nearly three inches long by a little less than half as wide. Superficially examined, the cocoon is alike at both ends, but when looked at more closely it is seen that the fibres at one end are left loose and open to allow the moth to pass through at emergence. The pupa lies within the cocoon with the anterior end toward the loosely woven end of the cocoon. The pupa is of a thick compact form with the abdominal annulations showing plainly. The cases for the legs, wings, and an-

tennae may be seen neatly folded down under the head and thorax. By the antennal cases the sex may be determined.

As the moth emerges a fluid is exuded from the mouth which softens the fibres of the cocoon, thereby making it easier for the delicate insect to work its way through the opening.

As the moth appears immediately after coming out of the cocoon, the wings are but mere watery sacks which hang downward from the body, and the abdomen is distended with fluids. The wings may soon be seen to be elongating and expanding, and in a short time are of full size, but the moth continues to remain quiet until they are dry. The color pattern of the wings is well shown in the photograph.

The male moth differs from the female in being slightly smaller and in having the antennae much larger and more conspicuous. Specimens taken around Bozeman have an expanse of wings of 4 to 4½ inches. The photograph is that of a male; the antennae of the female are much narrower and the abdomen is heavier.

Eggs were laid in confinement in the insectary on July 5th. The eggs are ellipsoidal, slightly flattened on one end, and with a small flat or depressed spot on the upper side. Length, 2.25 mm., or about 1-10 of an inch; width, 1.75 mm., or about 1-14 of an inch. The color is a dirty yellowish white. In nature the eggs are laid scattering on the leaves of the plant designed to be the food of the larvae. Our eggs under observation hatched on July 23rd.

LARVAL DESCRIPTIONS.

First stage (from hatching to first molt.) Maximum length when ready to molt 9 mm.; width of head 1.25 mm. Head glossy black or deep brown; mouth parts whitish with glossy black markings. General color of body smoky brown. Basis of tubercles of the dorsal four longitudinal rows orange yellow, excepting those at the anterior and posterior ends of the body. There are longitudinal rows of glossy black tubercles which are about as long as wide, and at the top of each is a cluster of about five stiff bristles, each being a little longer than the tubercle itself. Lower row of tubercles shorter and with bristles more numerous. Segment twelve has two tubercles of the dorsal two rows united into one which is larger than the others of the same row.

Second stage (following first molt). Maximum length of body 13 mm.; width of head 2 mm. Compared with first stage the general color of the body is orange yellow instead of black. The tubercles are the same, except that instead of being glossy black they are dark yellowish brown. Each segment has two black spots between each two prominences of each segment, and there are similar dark spots on the under side of the body. Head agreeing in color with the tubercles. A dark patch on the outside of each proleg.

Third stage (following second molt.) Maximum length of body 22 mm.; width of head 25 mm. In this stage the insect differs from the preceding in being yellowish green in color, in having the head with a median sutural stripe, the clypeus, and a patch on each side of the head, yellow. Tubercular prominences glossy black, as in the first stage, relatively reduced in size. Tubercles of the dorsal two rows, excepting the first segment, posterior to the head, with a yellow spot on each side.

Fourth stage (following third molt.) Maximum length 37 mm.; width of head 3.25 mm. Head all yellowish green, excepting a small dot on each side of the front and a patch surrounding the ocelli. General color of body yellowish green. Tubercles of dorsal two rows as follows: on second and third segments those of the dorsal two rows are club-shaped and coral red with black spines, while on the remaining posterior segments, to and including the twelfth, they are bright yellow with lateral black spots at the base. The other rows, together with all tubercles on first and thirteenth segments, blue. All spines black.

Fifth stage (following fourth molt.) Maximum length 66 mm.; width of head 3.6 mm. In this stage the larva differs very slightly from the preceding stage. The black spots in two's between the tubercles are much reduced in size.

Sixth stage (following the fifth molt.) Maximum length 80 mm.; width of head 4.6 mm. Differs from earlier stage in having the median four prominences of first segment reduced to mere tubercles which are a rich cobalt blue. Those of the second and third segments in the dorsal two rows are larger, and are coral red as in the earlier stage. Spines much reduced in relative size. Lateral tubercles cobalt blue at base and lighter apically.

The foregoing descriptions were made from specimens reared in the insectary.

This species is found in and near the Rocky Mountains from Alberta and Assiniboia in the north to Arizona in the south.
December 12, 1908.

DESCRIPTION OF PLATE I.

Figure 1. Cage in which ticks are fed on guinea pigs.

Figure 2. Female tick with 4814 eggs which she laid. These eggs are not piled as she left them but were arranged in a similar manner to be photographed.

Figure 3. Female tick before engorgement.

DESCRIPTION OF PLATE II.

Photograph of cocoon and male moth of Glover's silk moth, *Samia gloveri* Strecker, reduced one-half actual size.

DESCRIPTION OF PLATE III.

Photograph of larva of Glover's silk moth, reduced to about three-fifths actual size.

Photographs by W. S. and A. F. Berry.

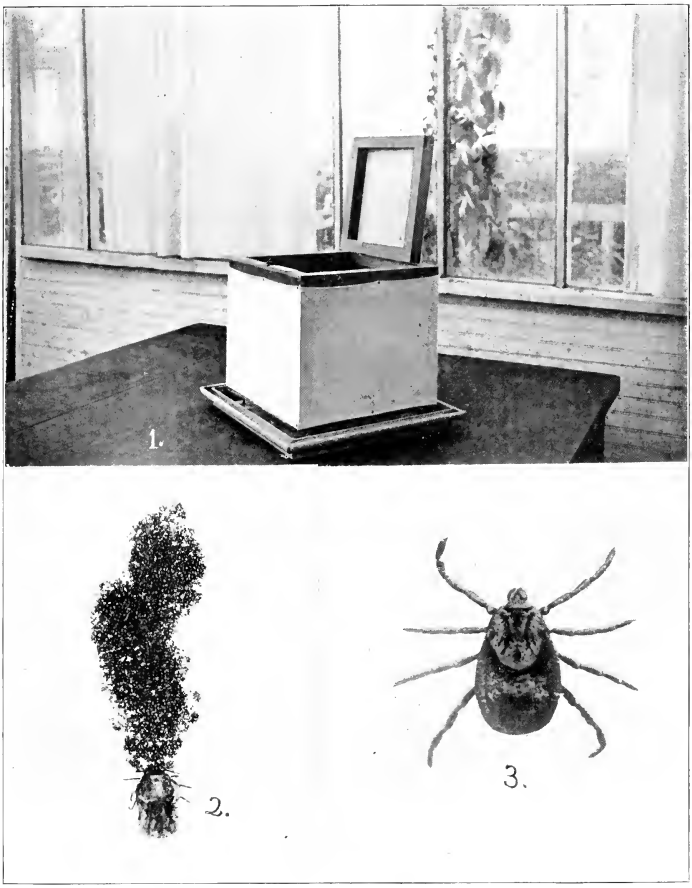

PLATE I.

PLATE II.

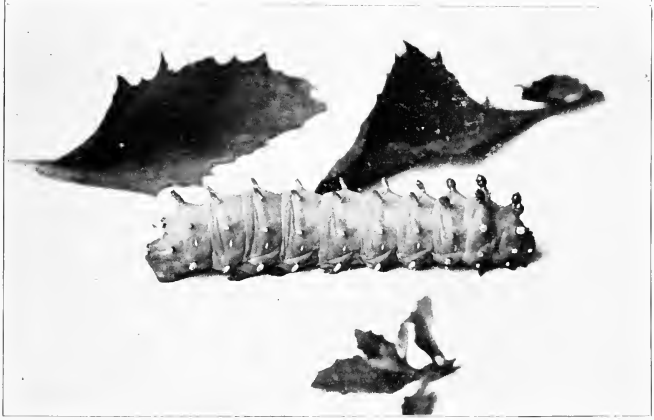

PLATE III.