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Montana Insect Pests 1939 and 1940

TWENTY-EIGHTH REPORT OF THE STATE ENTOMOLOGIST

BY

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AGRICULTURAL EXPERIMENT STATION
BOZEMAN, MONTANA

Bozeman, Montana.
January 1, 1941.

To His Excellency,
Governor Sam C. Ford,
Helena, Montana.
My Dear Sir:

I am pleased to present herewith the 28th report of the State Entomologist of Montana.

The Office of the State Entomologist was established by the Legislative Assembly of 1903 with the assigned duties of conducting field investigations on injurious insects within the State, and of investigating outbreaks of injurious insects and making recommendations for control.

Since the establishment of this office 37 years ago, agriculture within the State has increased greatly, and proportionately more time has been spent by the State Entomologist in carrying out the duties of the office. During the last decade of extensive outbreaks of grasshoppers and Mormon crickets, the major part of his time has been spent in control work.

The law prescribes that the office carry no salary other than that received from the College of Agriculture and Mechanic Arts and the Experiment Station, and twenty years ago this was a reasonable arrangement. At the present time, however, an equitable distribution of salary should include an item for this purpose in the annual appropriation for this office.

Grasshoppers, during the past biennium, have been again the major injurious insects within the State, and have received much attention. It is estimated that out of a possible loss of $37,365,612 to crops because of infestations of 'hoppers and Mormon crickets, a savings of $22,909,265 has been realized because of cooperative control campaigns with the United States Department of Agriculture in the last four years.

It should be pointed out that campaigns against such injurious insects have been made possible only through the assistance of Federal funds. Grasshopper bait materials have been purchased for use in the State, and during the past two years equipment has been purchased and crews hired for baiting on abandoned land. While the figures on total Federal expenditures for grasshopper control during the past two years are not available, of the $163,046.10 spent on Mormon cricket control in 1939 and 1940, $125,042.96 came from Federal funds. Practically all of the remainder came from county and individual sources.

Funds made available by the State were far too small even to care for supervision.

A few newly introduced pests are recorded herein, and mention is made of one which is within striking distance of us in the West.

Respectfully submitted,

HARLOW B. MILLS,
State Entomologist.

MONTANA INSECT PESTS 1939 AND 1940

Twenty-Eighth Report of the State Entomologist

Harlow B. Mills

INTRODUCTION

The years 1939 and 1940 were characterized, as have been all in the decade just past, by intense grasshopper infestations in a large part of the State. These pests again were by far the dominant injurious insects, and their numbers were tremendous.

During the past three years, flights of the lesser migratory locust (*Melanoplus mexicanus* Sauss.) have been one of the outstanding biological phenomena of this region. This species, which is known to have migratory tendencies, has been comparatively quiescent in the State for many years, and the migrations which occurred were of small proportions and for short distances. As was reported in the Twenty-Seventh Report of the State Entomologist[1] the native populations of all species of grasshoppers in the State were at a low ebb in 1938. On the first day of July of that year, immense numbers of the lesser migratory locust invaded the State from the southeast, traveling as far to the northwest as Blaine, Fergus, Petroleum, Rosebud, and Treasure counties. Large numbers of eggs were laid in the east-central area, involving Phillips, Valley, Daniels, Sheridan, Roosevelt, Richland, Dawson, Wibaux, Fallon, Prairie, Custer, Rosebud, Treasure, Garfield, and Petroleum counties. This area was delimited by the survey of the autumn of 1938, and preparations were made to combat the hatching 'hoppers in the spring of 1939. The control operations were complicated by the deposition of large numbers of eggs in idle and reverted lands, and in depleted range which was being invaded by such annual weeds as Russian thistle and tumbling mustard.

To meet this new and unusual condition, the United States Department of Agriculture, through the Bureau of Entomology and Plant Quarantine, instituted a new program, furnishing bait, mixing, transportation, and crews to poison infested, reverted, and range land from which migrations might originate. This was in addition to the usual cropland program in which bait materials were furn-

[1]Montana Experiment Station Bulletin 366, 1939, pp. 12-16. (Out of print. Available only in libraries.)

ished to farmers. The area involved was so large, though, that great numbers of grasshoppers reached maturity and migrated in the fall of 1939 (figure 1).

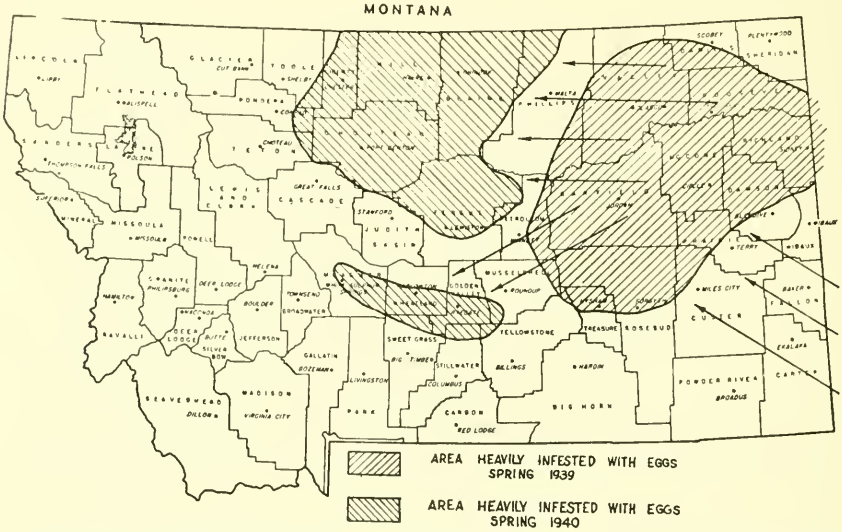

Figure 1. Egg infestations (*Melanoplus mexicanus*) in the springs of 1939 and 1940, resulting from the invasion of 1938. Arrows show direction of flight.

This new migration was primarily to the northwest again, and flying 'hoppers invaded an area as far west at Toole, Pondera, Teton, Chouteau, and Fergus counties. The survey in the fall of 1939 indicated that the area so heavily infested in the summer of that year was now practically devoid of these pests, while an area involving Phillips, Blaine, Hill, Liberty, Toole, Pondera, Teton, Chouteau, and Fergus counties which had received the migration, was heavily infested with eggs. Hill County, which had an infestation of 83 per cent, was the most heavily infested county ever recorded in the country.

Fortunately, practically all of the eggs were laid in crop and idle land, and the range did not present the problem which it did in east-central Montana in the summer of 1939. The special Federal program was again in operation during the 1940 control season but was largely limited to the treatment of roadsides. The hatch in the spring of 1940 was well indicated by the previous fall's survey, but the intensity of the hatch was not forseen.

Migrations commensurate with those of the summers of 1938 and 1939 did not occur during the summer of 1940, although there was a great deal of general movement. The 'hoppers were in a

mood to fly, and did infest parts of Toole, Pondera, Teton, Wheatland, Golden Valley, Musselshell, Rosebud, Petroleum, and possibly Valley, which were not so heavily infested during the summer. This lack of mass flight for considerable distance was probably due to the weather conditions during the flight period, and to the great reduction in populations as a result of the intensive control program.

It is interesting to note that the migration of 1938 invaded an area in which grasshoppers were on the decline and that there were, considering the State as a whole, fewer of them in 1940 than in 1939. They were apparently able to hold up their populations primarily on the strength of the immense numbers present even though conditions were not the best for their increase.

MAJOR INSECT CONTROL PROBLEMS

Grasshopper Control in 1939

The unusual conditions prevailing during 1939 in the badly infested area in eastern Montana were (1) high infestations on depleted range, (2) almost a pure infestation of *Melanoplus mexicanus*, (3) a hatch almost two weeks earlier than was expected, (4) an extremely even hatch, (5) uniformly excellent kills with poison bait, and (6) high local interest in the control campaign. While there was a high incidence of egg predation by bee fly and blister beetle larvae, the large numbers of eggs which remained produced excessive populations. In irrigated valleys the two-striped grasshopper (*Melanoplus bivittatus*) appeared locally in some numbers, and along fence rows and roadsides in Judith Basin and Fergus counties they were moderately abundant. There was very little hatch until May 5th, when a spontaneous hatch occurred in parts of Prairie, Custer, Rosebud, Dawson, McCone, and Richland counties. In surrounding areas the appearance of nymphs was delayed a little. The evenness of the hatch was demonstrated by counts made in the area the fourth week in May. At that time 68.9 per cent were in the second instar, 23.3 per cent in the first, and 7.7 per cent in the third, with over 90 per cent of the eggs hatched. A great deal of rain fell for about three weeks beginning May 19th. The counties east of a line drawn through Carbon and Phillips counties had received 100 per cent of their normal rainfall for the April to August period by the last of July, and most of Valley, Daniels, Sheridan, and Roosevelt counties had received 125 per cent of the normal. Baiting operations were stopped, but conditions were such that some periodic feeding kept most of the 'hoppers alive. Mild migration movements were first noted on the 25th and 26th of June, and they continued until the latter part of July.

In 1937 the big-headed grasshopper (*Aulocara elliotti*) was second only to *M. mexicanus* as the dominant species in the State. In

1938 its numbers along with range species with which it usually associates, were negligible.

Disease was a factor in the reduction of numbers of the two-striped grasshopper, and sarcophagid flies were locally abundant throughout the infested areas.

In spite of crop losses amounting to $2,867,923, the campaign was in many respects very successful. Cooperation among all of the agencies involved was excellent, and the interest of the farm operators high. It is estimated that $6,835,758 in crops were saved as a result of the campaign. Bait usage by counties is given in table 1.

TABLE 1.—BAIT USAGE (DRY WEIGHT) BY COUNTIES, 1939-1940.

County	1939 Tons	1940 Tons
Beaverhead	2.5	3.1
Big Horn	8.1	25.75
Blaine	882.5	2,976.98
Broadwater		2.0
Carbon	.6	
Cascade	110.5	353.0
Chouteau	351.0	3,209.0
Custer-Powder River	573.35	
Daniels	1,342.0	
Dawson	1,838.5	
Fallon-Carter	173.0	43.0
Fergus	252.25	4,786.0
Flathead		19.0
Gallatin	12.25	4.45
Garfield	1,059.9	
Glacier		.75
Golden Valley-Musselshell	34.0	37.10
Hill	160.0	6,810.0
Jefferson		
Judith Basin	135.6	165.05
Lake	39.0	1.0
Lewis and Clark	3.0	25.25
Liberty	20.0	1,483.7
Madison		2.0
McCone	2,437.6	
Meagher	1.45	
Missoula	4.5	
Park		
Petroleum	39.0	.6
Phillips	237.5	536.0
Pondera	58.0	588.0
Powell		1.0
Prairie	740.75	
Ravalli	5.0	
Richland	4,884.0	.5
Roosevelt	5,474.5	40.0
Rosebud	870.0	
Sanders	9.0	
Sheridan	543.0	
Stillwater	2.5	6.50
Sweet Grass	.2	4.75
Teton	71.0	550.0
Toole	120.0	232.0
Treasure	281.0	
Valley	3,599.0	6.0
Wheatland	4.0	8.0
Wibaux	523.5	
Yellowstone	6.0	67.75
Total	26,909.88	21,988.23

Grasshopper Control In 1940

Again in 1940 the dominant species in the State was the lesser migratory locust. It is estimated that an intensive educational campaign, carried on during the preceding winter mainly by county agents, was successful in reaching approximately 7,500 people personally, and the farm operators in the badly infested area in north-central Montana were ready when the hatch began. Little 'hoppers appeared earlier again in 1940 than was anticipated. They were first seen about May 11th, and by the 20th some injury was evident. Nymphs appeared in light soil above Gildford in Hill County before any were noted anywhere else along the upper tier of counties. The rush on the mixing stations was almost explosive, a comparatively large amount of bait materials on hand in the critically infested counties was soon exhausted, and for a short period sawdust was not received in sufficient quantities to supply the great demand. As soon as shipments were adjusted no further trouble was experienced with shortages in bait materials.

Some disease in *M. bivittatus* and *M. packardi* was noticed, and sarcophagid flies were moderately abundant in local areas.

The 1940 campaign was successful in saving an estimated $7,012,-763, and losses were estimated to amount to $2,155,631. Other than for a temporary shortage of sawdust mentioned previously, the campaign was comparatively smooth-running, cooperation among all agencies involved was excellent, and the interest of the farmers high in the badly infested area.

Bait usage by counties for the 1940 season is given in table 1.

Preparation and the Success of Grasshopper Campaigns

It has been amply demonstrated during the past three years that the success of a grasshopper control campaign is directly proportional to the preparation for it, both in the field of education and

TABLE 2.—LOCAL CONTRIBUTIONS AND PARTICIPATION, 1939-1940

	1939	1940
Number of mixing stations	57	37
Average weight (wet) per sack	80	80
Counties actively engaged	21	10
Farmers using bait	9,588	5,250
Average farmers per county	457	525
Wet bait used	38,479	32,980
Mechanical bait spreaders		2,891
Cropland baited (acres)	1,272,289	2,119,451
Range or pasture baited (acres)	1,021,623	86,558
Estimated losses	$2,867,923	$2,155,631
Estimated savings	$6,835,758	$7,012,763

in maintaining quantities of materials at strategic places previous to the actual field work. In 1938, when there was no warning that the counties in eastern Montana would be invaded, and practically no preparation was made for the influx from the southeast, crop losses for the State were estimated to be $6,831,090, and the savings

about one-seventh of that amount, or $940,924. In 1939 preparations were made in advance for a strenuous campaign, and in spite of difficult complicating factors, the savings were estimated at $6,835,758, and the losses considerably less than half of that amount, or $2,867,-923. Again in 1940 there was warning of the possibility of a difficult situation in north-central Montana, and extensive preparations were made to meet the condition. The savings amounted to an estimated $7,012,763, and the losses were less than a third of that amount, or $2,155,631 (table 2).

In order to make preparations to meet such emergencies, the annual grasshopper survey is the most valuable field tool at our disposal. The accuracy of prediction, as to areas involved, has been increasing from year to year. It has been obvious, however, that errors have been large on the basis of predicting the amount of bait which may be used in a county. There are so many variable factors which affect the amount of bait which may be used (weather, intensity of infestation, availability of outside assistance, cooperation of involved agencies, ability of personnel, use of cultural methods, natural control, time and evenness of hatch, flights, species involved, survey adequacy, type of farming, etc.) that wide differences between bait prediction figures and bait usage figures are to be expected.

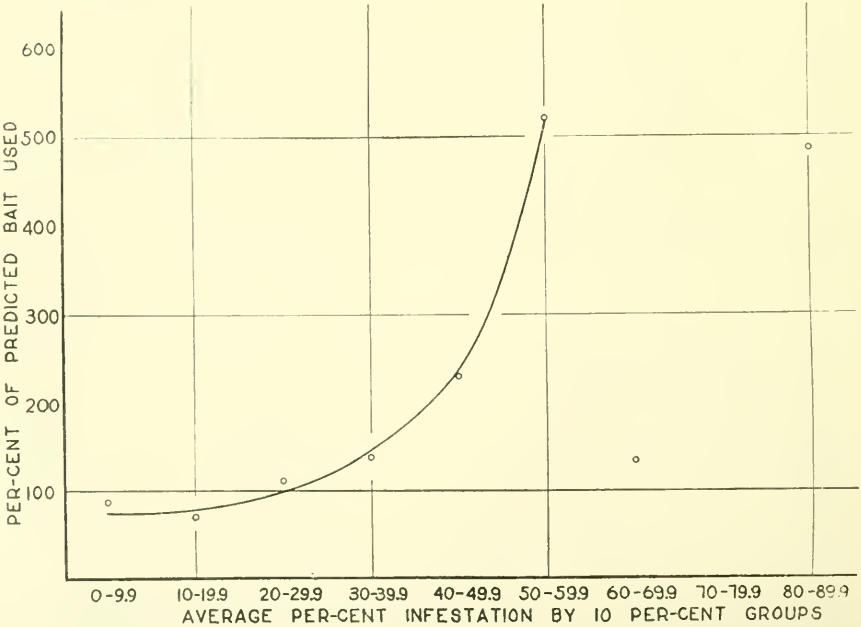

Figure 2. Correlation between percentage of predicted bait used and the intensity of infestation. Montana counties, 1937 to 1940.

During the last two years a general correlation has been noted between the intensity of the infestation and the percentage of the predicted bait which is used. When the per cent infestation (the per cent of cropland which may need baiting) in a country is low, the bait usage is correspondingly low, and when the per cent infestation is high, much more than the predicted amount may be used (figure 2). This general observation led to the compilation of data in an endeavor to ascertain the inclusiveness of this correlation in counties exhibiting all variations in percent infestation. The per cent infestation for all infested Montana counties, together with the per cent of the predicted bait used, was tabulated for 1937, 1938, 1939, and the north-central counties for 1940. The per cent infestations were averaged in 10 per cent groups, and the per cent of predicted bait used, on this basis, is given in the table below:

Per Cent Infestation	No. Times Occurring	Per Cent of Prediction Used
0 to 9.9	17	88.3
10.0 to 19.9	31	70.8
20.0 to 29.9	34	110.9
30.0 to 39.9	14	139.8
40.0 to 49.9	8	231.9
50.0 to 59.9	6	523.7
60.0 to 69.9	1	136.0
70.0 to 79.9	0	——
80.0 to 89.9	1	486.0

The progression calculated in this table appears superfically to be satisfactory until the 60.0 per cent to 69.9 per cent group is reached. This group and the ones following include so few samples that no significance could be attached to them. It is likely that a larger number of samples in the first three groups would bring the percentage of predicted bait which was used lower than those given above.

While there seems to be a good correlation between these two factors when averaged in 10 per cent groups, the data indicate a great deviation on both sides of the mean, and it will take more data than are at hand to put this correlation on a sound basis.

In order to discover the effect of climate and geography on this correlation, the data were compiled for counties west of the Divide. During the period under study these counties consistently used less than the predicted amount of bait regardless of the per cent infestation obtained from the survey.

If this study has a value it will be in allowing an intelligent change in the method of calculating the amounts of bait needed. It should indicate the amount of correction necessary in different ecological habitats infested with injurious numbers of grasshoppers. It may necessitate a division of the chronically infested areas re-

gardless of State lines, and preparations for campaigns may have to be made on such an area basis rather than on a county basis.

Mormon Cricket Control 1939-1940

The period of 1931-1938 marked the most extensive Mormon cricket invasion of crop areas ever recorded in the State. The seriousness of the situation has greatly decreased in the last two years. During 1938 the infestation reached its peak, with an estimated 2,209,078 crop acres and 5,542,407 range acres infested. Most of these 7,751,485 acres were quite thickly populated with crickets. In 1939 there was a decrease of approximately 74 per cent in infested cropland and 43 per cent on the range. In 1940 still another decrease was noted; infested crop areas were reduced 69 per cent and range 38 per cent. Comparison of the peak infestation of 1938 with the condition at the end of the 1940 campaign indicated a two-year reduction of 78 per cent on cropland and 84 per cent on the range, giving a total reduction for all infested acres of 81 per cent (table 3).

TABLE 3.—DECREASE IN MORMON CRICKET INFESTATION 1938 TO 1940

	1938 to 1939		1939 to 1940		1938 to 1940	
	Average decrease acres	% decrease	Average decrease acres	% decrease	Average decrease acres	% decrease
Crop	1,626,258	74	218,800	69	1,845,058	78
Range	1,715,007	31	2,628,300	38	4,343,307	84
Total	3,341,265	43	2,847,100	65	6,188,365	81

Several factors probably are responsble for this decrease in infestation. It is apparent that control work is responsible for a good deal of the reduction. Besides the destruction of tremendous numbers of crickets by the use of dust, bait, and oil and metal barriers, there are indications that when the crickets are disturbed a large number of the eggs which they lay will not hatch. Climatic conditions in all likelihood play an important part, although it is not known what conditions affect the crickets adversely. In past years parasites and predators have been important agents in reducing populations of crickets. In most areas in the State the egg parasite, *Sparaison pilosum* Ashm., has been noted in increasing numbers for several years, and large numbers of parasitized eggs have been collected. The sphecid predator, *Palmodes laeviventris* Cress., has been increasing in numbers, and was very abundant in certain areas in 1940. Field mice habitually dig out the eggs and eat them. In one area where the eggs were concentrated the mice had destroyed 43 per cent of the eggs. When crickets are available, various species of birds feed extensively on them. As many as 53 hawks (probably Swainson's and the red tail) have been seen preying on a single band in Beaverhead County. An examination of regurgitated hawk pellets disclosed a large number of cricket legs, and other indigestible heavily sclerotized parts. Other birds which were no-

ticed feeding extensively on these insects were crows, magpies, sage hens, Brewer's blackbirds, meadow larks, horned larks, and lark buntings. In many cases the bands of crickets could be located by the flocks of birds hovering over them. It has also been observed that coyotes and skunks eat large numbers of the pests.

Control in 1939.—The 23 counties participating in the 1939 campaign were Big Horn, Blaine, Carter, Carbon, Cascade, Chouteau, Custer, Fergus, Gallatin, Golden Valley, Hill, Judith Basin, Lake, Meagher, Musselshell, Park, Phillips, Powder River, Rosebud, Sanders, Stillwater, Sweet Grass, and Yellowstone. The program was on a crop-protection basis with most of the work being done on or within five miles of cropland. In isolated areas, however, crickets were occasionally controlled to rid a county of an infestation. In most of the above counties the program was very successful, and populations were reduced by the campaign and natural factors to such an extent that no control work was necessary in 1940.

Control in 1940.—The 1940 control program was carried out on the same basis as the previous one. There were only five counties involved, Big Horn, Chouteau, Judith Basin, Sanders, and Yellowstone having infestations severe enough to make control work necessary. It is doubtful if control work will be necessary in Chouteau, Judith Basin, and Yellowstone counties in 1941. In the fall of 1940 a large migration entered Beaverhead County from Idaho, and there has been some increase in Meagher County (table 4).

TABLE 4.—MORMON CRICKET CONTROL ACTIVITIES

	1939	1940
Crop savings	$489,215	$99,840
Crop losses	16,280	125
Acres protected	235,885	72,123
Acres injured	13,268	75
Crop acres infested	582,820	364,020
Range acres infested	3,827,400	1,199,100
Total infested acres	4,410,220	1,563,120
Acres dusted	107,207	16,052
Acres baited	4,567	5,663
Equipment and materials used		
Hand dusters	439	92
Power dusters	79	30
Mixed dust (pounds)	516,293	83,301
Mixed bait (pounds)	93,540	108,120
Oil barrier (miles)	114.8	0
Oil (gals.)	36,831	0
Metal barrier (miles)	150.9	3

OTHER IMPORTANT INSECTS OF 1939 AND 1940

Clover Insects

The past two years have been marked by an increase in damage caused by clover insects in the Flathead district, and the damage which they have caused has run into several hundred thousand dollars. The important insects involved were the clover seed midge, the clover root borer, and clover aphids.

Clover seed midge (*Dasyneura legumincola* (Lint.)).—The first and only record of this insect in the State until the present was of an outbreak at Arlee in 1917. In both 1939 and 1940 its attack on red clover in the vicinity of Ronan, Lake County, greatly reduced the seed yield of this important crop. Its attack is characterized by the failure of the florets to open and by the later absence of seed. Tiny pink or orange larvae may be found in the injured clover heads. The winter is spent in the larval stage in the soil. In the early spring these larvae pupate and in May or June emerge as tiny midges which are slate gray with reddish abdomens. The eggs are laid about the calyx and the hatching larvae enter the flowers. When they are full grown they fall to the ground, usually during a period of rain, and complete the cycle. There are usually two generations. To control these insects the clover should be cut a little before the uninjured heads have reached full bloom, and all volunteer clover should be eliminated. This destroys the larvae which would otherwise develop into the second generation of adults, and usually allows ample time for the second growth to produce seed.

The clover root borer (*Hylastinus obscurus* (Marsh)).—This is also present in the Flathead area. The main injury caused by this beetle results from the tunneling of the white, legless larvae in the roots (figure 3). The plants thus attacked wilt, turn brown, and finally die. Although this insect may attack several cultivated legumes, including alfalfa and sweet clover, it prefers red and mammoth clover. This insect does not usually injure stands which are one or two years old, doing the most of its damage to older fields. When any quantity of injury is noticed in the fields, (intense injury is not common), the only control recommended is to plow under the crop.

The clover aphid (*Anuraphis bakeri* Cowen).—This aphid has been abundant in the same area as the two insects discussed above, during 1939 and 1940. Although the plants may not be greatly injured by the feeding of this insect, the seed crop losses may be great because of its secretion of honeydew which mats the heads and cakes the seeds in storage. Close pasturing early in the season or cutting the first crop close to the ground and promptly removing the hay may allow a seed crop to be produced comparatively free from the damage which this insect causes.

Grain Insects

During the last biennium the requests for information concerning the control of insects infesting stored grains have increased considerably over previous years. Although the action of many of those sent in or collected by members of the staff may not actually injure the grain in which they were found, their presence may result

Figure 3. Root of red clover showing tunnels and white larvae of clover root borer.

in dockage when it is sold. Those which have come to our attention recently are listed below:

Granary Weevil (*Sitophilus granarius* (L.)).—This insect, a little smaller than a grain of wheat, is a brownish-black weevil. It is widely distributed throughout the world, and seems to prefer a temperate climate. The little white legless larvae hollow out the inside of the wheat kernels, and may be extremely injurious to stored grains in the State. This pest has been reported from Belgrade, Billings, Brussett, Chinook, Custer, Deer Lodge, East Helena, Flathead County, Fromberg, Hardin, Havre, Joliet, Jordan, Melstone, Miles City, and Plains.

Sawtooth Grain Beetle (*Oryzaephilus surinamensis* (L.)).—This is a slender, flat, light- to dark-brown beetle which is also world-wide in its distribution. The sides of the thorax bear a number of saw-tooth-like projections, from which the insect gets its common name. Both in the larval and adult stages it attacks grain and grain products, but it is not so important a pest as the granary weevil. It has been found in the State in Belgrade, Billings, Bozeman, East Helena, Missoula, and Ronan.

Flat Grain Beetle (*Laemophloeus* sp.).—This is the smallest of the grain-infesting insects which has been found in the State. It is about one-sixteenth of an inch long, flat, elongate, and reddish brown. It apparently cannot live in sound grain, usually following up the damage caused by other grain insects or infesting grain or meal which is out of condition. The genus has been found infesting grain or grain products at Belgrade, Billings, Chinook, Havre, and Hardin.

Broad-Horned Flour Beetle (*Gnathocerus cornutus* (F.)).—This beetle is about one-sixth of an inch in length. It gets its name from the mandibles of the male which extend in front of the head conspicuously and curve inwardly. It is reddish brown in color. It may be found in grain but prefers meal or flour. Although it is found throughout the world, it is comparatively rare in the Great Plains region and in Montana we have a single record from Deer Lodge.

Confused Flour Beetle (*Tribolium confusum* Duv.).—The confused flour beetle is a shiny, reddish-brown beetle, flattened and oval in shape, about one-seventh of an inch long. It is a very general feeder on grain and grain products, and is probably the most important and destructive of the pests attacking flour in the United States. It may be found wherever grain or grain products are stored, especially in flour mills and in homes. We have records of extreme abundance in houses in various parts of the State. It is generally distributed over the world, and has been reported in Montana from Bozeman, Butte, Forsyth, Great Falls, Missoula, Redstone, Turner, and Wolf Point. Accidental ingestion of these pests by humans is not an uncommon occurrence. Investigations recently reported[1] from the Montana Agricultural Experiment Station indicate that cooked confused flour beetles in all stages when consumed in oatmeal are not injurious to humans, even when eaten in rather large doses.

Foreign Grain Beetle (*Ahasverus advena* (Waltl.)).—This tiny, robust, reddish-brown insect seldom if ever attacks clean, dry grain. It is, therefore, not an important pest in stored grain, preferring damp mouldy material and feeding on the moulds present. It is widely distributed throughout the world, but in Montana has been found only at Amsterdam, Custer, and Billings.

[1]Mills, H. B. and Pepper, J. H., J. Econ. Ent. Vol. 32, No. 6, pp. 874-875, 1940.

Mealworms (*Tenebrio molitor* L. and *Tenebrio obscurus* F.).—Of these two large grain insects, the yellow mealworm (*T. molitor*) appears to be more common than the dark mealworm (*T. obscurus*) in Montana. The adults are over one-half of an inch long, elliptical in shape, without the strong body constriction which is noticeable in the cadelle. The yellow mealworm adult is shiny and dark brown to black. The adult of the dark mealworm is similar in size and shape but is dull pitchy black in color. The larvae are elongate, cylindrical, shiny, about an inch long, yellowish in the yellow mealworm and darker in the other species. They breed in refuse grain and coarse cereal and mill products, and are partial to moist situations. There is but one generation a year and, as they feed externally upon grains, they may be easily removed from grain by fanning and screening. The yellow meal worm has been reported from Bozeman, Culbertson, Darby, Dillon, Florence, Great Falls, Hamilton, Hardin, Helena, Joliet, Kalispell, Malta, Miles City, Missoula, and Wibaux. The dark mealworm is known from Bozeman, Great Falls, Hardin, and Hill County.

Cadelle (*Tenebroides mauritanicus* (L)).—One of the larger grain pests, the Cadelle is about one-third of an inch long, oblong, flattened, and black with a conspicuous constriction between the thorax and the abdomen. The larva is chalky white, fleshy, and three-quarters of an inch long when full grown. The tip of the abdomen ends in two dark horns. Both the larva and the adult feed on grain and grain products, and often devour only the germ from the kernel. In Montana there are records of its occurrence in Great Falls and Hardin.

Meal moth (*Pyralis farinalis* L.).—The adult of this pest is a rather fragile looking moth with a wing spread of approximately an inch. The forewings are characteristically marked with deep brown bases and tips, these areas being separated from the irregular intermediate straw-colored stripe by white lines. The underwings are brownish gray, which coloration may be broken into spots toward the hind margin. The whitish larva becomes about an inch long when full grown. It spins a tube as it develops, and trails a silken thread behind it wherever it goes. This webbing is conspicuous in grain which is heavily infested or which has supported this pest for some time. It is a general feeder in grains, cereals, and is sometimes found in hay or other dried vegetable material. It prefers damp materials and is often abundant where grain or grain products are allowed to accumulate. The larvae, which may be tinged with orange at both ends, may gnaw through sacking and cause such materials to spill. There are records in the Montana Insect Pest Survey of its occurrence near Culbertson, Forsyth, Hardin, Kremlin, and in Garfield County.

Mediterranean Flour Moth (*Ephestia kuehniella* Zell.).—The larvae of this small greyish moth may be found infesting accumulations of flour, meal, or waste grain, webbing the material to-

gether. When they are full grown they are about one-half inch long and white or slightly pink in color. Not especially abundant in Montana, this species has been reported from Bozeman, Hardin, Miles City, and Moore.

Indian Meal Moth (*Plodia interpunctella* (Hbn.)).—The adult of this species is a conspicuously marked little moth. The outer two-thirds of the forewings are copper brown, and the inner third is whitish gray. The wings expand to about three-fourths of an inch. The larvae, when fully developed, are about one-half of an inch in length and are dirty white with occasionally a greenish tinge. They web the materials which they infest and may feed on grain, grain products, dried fruits, nuts, and similar food stuffs. They have been reported from Billings and Bozeman in the State.

Control of Grain Insects

Damage from grain insects may be greatly reduced if protective measures are taken to prevent infestations. Bins in which grain is to be stored should be thoroughly cleaned before new grain is stored. New bins should be so constructed that they are off the ground, and that grain cannot accumulate beneath the floor, between walls, etc. Dry grain should be stored, and there should be good ventilation; it is said that grain containing seven or eight per cent moisture is too dry and hard for most insects and that several cannot exist in flour containing eleven per cent or less moisture. Steel or concrete bins are more desirable than wooden structures. Old grain sacks should not be stored near granaries and should not be used again until they have been fumigated or otherwise freed of live insects.

Stored grain which has become infested with grain pests is best treated by fumigation, and carbon disulphide is the most economical and efficient material which can be used for this purpose. This compound is a colorless, rapidly evaporating liquid, which is approximately one-fourth heavier than air (1.26:1). If properly applied to the top of a bin it penetrates downward, killing the insects without injuring the grain. It should be remembered that *carbon disulphide is inflammable and under certain conditions explosive.* Even lighted cigars or cigarettes should be kept away from a building being fumigated with this material. The bin to be treated should be made as tight as possible, and one pound of carbon disulphide should be used for every 100 cubic feet or 80 bushels of grain. Shallow pans may be imbedded in the surface of the grain and the liquid poured into them and allowed to evaporate, or it may be poured over old sacks or blankets thrown into the bin. Fumigation should not be attempted at temperatures below 60°F. U. S. D. A. Farmers' Bulletin 1483 gives further information on this subject.

MISCELLANEOUS RECORDS AND OBSERVATIONS

Say's Plant Bug (*Chlorochroa sayi* Stal).—This bug has been attacking grain crops primarily in north-central Montana every year since 1932. Its attacks have fluctuated in intensity and in localities involved from year to year, sometimes being very destructive locally. Other than in the Triangle area, where it was first noticed in injurious numbers, and where it has been a problem ever since, it has been seen damaging wheat south of Hardin, on Rosebud

Figure 4. Eggs of Say's plant bug on Russian thistle, the common spring host for this pest. Enlarged about 3 to 4 times.

Creek in Rosebud County, and near Savage. This insect overwinters in the adult stage beneath mats of weeds, straw, etc., and has a spring generation primarily on Russian thistle and tumbling mustard. Anything which can be done to destroy the hibernating quarters will reduce the overwintering populations, and an effort should be made to return to grass reverted fields upon which annual weeds are growing (figure 4).

Grass Plant Bugs.—But one instance of movement of the grass plant bug (*Labops hesperius* Uhler) into wheat has been observed

during the past two years. In 1939 these insects invaded a wheat field on Reece Creek north of Bozeman, causing the usual mottling of the leaves. The wheat was about eight inches high at the time, and soon outgrew the damage. *Conostethus americanus* Knight has not been reported as injurious since 1938.

The Potato and Tomato Psyllid.—A survey was made June 19-27, 1939, of all Montana potato areas except those in Flathead and Lake counties. Specimens of *Paratrioza cockerelli* (Sulc) were collected in Lewis and Clark, Cascade, Blaine, Phillips, Valley, Richland, Dawson, Custer, Rosebud, Yellowstone, Carbon, and Stillwater counties. Despite the presence of psyllids at this early date, the subsequent 1939 psyllid losses dropped far below those of 1938. In many parts of the State light psyllid infestations were obscured by heavy Rhizoctonia infections which were very prevalent. However, slight potato losses directly attributable to *Paratrioza cockerelli* were observed at Trident in Gallatin County, at Malta in Phillips County, and in the Yellowstone Valley (Park City, Billings, Huntley, Custer).

A survey was made June 22-27, 1940, of potato plantings in the eastern two-thirds of Montana. Neither adults nor immature stages of *Paratrioza cockerelli* were found west of a line connecting the western borders of Phillips and Yellowstone counties. Adult *Paratrioza cockerelli* were collected in Phillips, Valley, Richland, Dawson, Custer, Rosebud, Big Horn, and Yellowstone counties. Subsequent summer observations of infestations in Yellowstone County showed a gradual increase in populations of psyllids until harvest time, afer which a general migration occurred to tomatoes, egg plant, and peppers. Slight losses in potato yields, unnoted by growers, probably resulted from these infestations. A few farmers sprayed their potatoes (1 gal. liquid lime sulfur testing 28° Baume, in 35 gallons of water) early in the season as a precautionary measure. No reports of psyllid damage were received from growers in the State.

Pear Psylla.—The pear psylla (*Psyllia pyricola* Forst.) is a small, pale-orange to reddish-brown sucking insect. It is one of the most important pests of the pear. When abundant, the leaves turn brown, the fruit drops prematurely or is of poor quality, and both the leaves and fruit may be covered with sticky honeydew which the insects produce. This insect was introduced into Connecticut from Europe in 1832 and has spread over the eastern states. Recently it was introduced into the Spokane area in Washington, and it now presents a threat to the western part of Montana at least. Ravalli, Missoula, Lake, Flathead, and Sanders counties were surveyed from July 23rd to 30th to discover whether or not the insect had reached the State. The following is a tabulation of the results of the survey:

County	No. premises examined	No. trees by variety			No. times psylla collected
		Bartlett	Flemish	Unknown	
Ravalli	34	56	3	74	0
Missoula	11	21	26	9	0
Lake	13	53	61	18	0
Flathead	3	0	12	5	0
Sanders	12	11	1	10	0
Total	73	141	103	116	0

It is likely that this insect does not at present exist in the State. Any of the symptoms mentioned above occurring on pears should be reported and specimens sent immediately to the State Entomologist, Bozeman, Montana.

Lettuce Root Aphis.—During the first week in August 1940, a report was received of injury being suffered by a large planting of head lettuce in the Gallatin Canyon. An examination of the field revealed a large population of root lice attacking primarily the second planting. This insect was identified through the kindness of Miss M. A. Palmer as *Pemphigus bursarius* Linnaeus. The planting most heavily attacked was practically a complete loss; the rest of the field was heavily irrigated for some time after the discovery of the insects, and, although they were present on the last two cuttings, the damage noticed was small.

Spruce Gall Lice.—Cooley's spruce gall louse (*Adelges cooleyi* Gill.) is abundant throughout the State both on native and ornamental trees. There seems to be an individual susceptibility in stands of Engelmann spruce (*Picea engelmanni*), some trees being heavily infested, and others close by practically immune. It has been noted further that black hill spruce (*Picea glauca albertiana*) and Norway spruce (*Picea excelsa*) are more heavily infested than native forms. Another spruce gall aphis (*Pineus pinifoliae* (Fitch)) was found attacking Engelmann spruce at the head of Squaw Creek, Gallatin County, June 26, 1940, at an elevation of approximately 9000 feet. The terminal gall caused by this insect differs from the gall of Cooley's spruce gall louse in being composed of flat scales, giving it a cone-like appearance. (See figure 5). This species has not as yet been recorded as damaging ornamentals in the State.

Although research on the control of the spruce gall louse in Montana is not complete, good control has been obtained in other parts of the country. A spray consisting of one quart of 40 per cent nicotine sulphate and five gallons of miscible oil to 200 gallons of water has been found to be satisfactory. The spray is applied in the spring when the young are hatching from the cotton-covered egg masses and colonizing the new growth.

Striped Cucumber Beetle.—This pest of cucurbits (*Diabrotica vittata* (Fabr.)) was neither reported nor collected in 1939, although in 1938 distribution included Daniels, Roosevelt, and Yel-

Figure 5. Spruce gall aphis (*Pineus pinifoliae* (Fitch)) on Engelmann spruce. The galls on these twigs, shaped like cones, are caused by the feeding of the aphids at the base of the needles on the new growth. The cottony mass near the base of the left twig covered the eggs previous to hatching. In the gall on the right can be seen the adult insects at the bases of the scales. Galls enlarged 1¼ times.

lowstone counties. No cucumber beetles were noticed in 1940 until three specimens were swept from pepper and egg plants near Billings in September and October. On Ocober 24, 1940, hundreds of specimens were collected in a cantaloupe patch near Billings. They were feeding on mellow cantaloupe, gouging sizable holes in fruit which had passed a salable condition. (See figure 6). From one to two dozen beetles were commonly found on single cantaloupe, while fruit nearby might show no damage. Operators of this truck garden had noted no beetles nor damaged cucurbits earlier in the season.

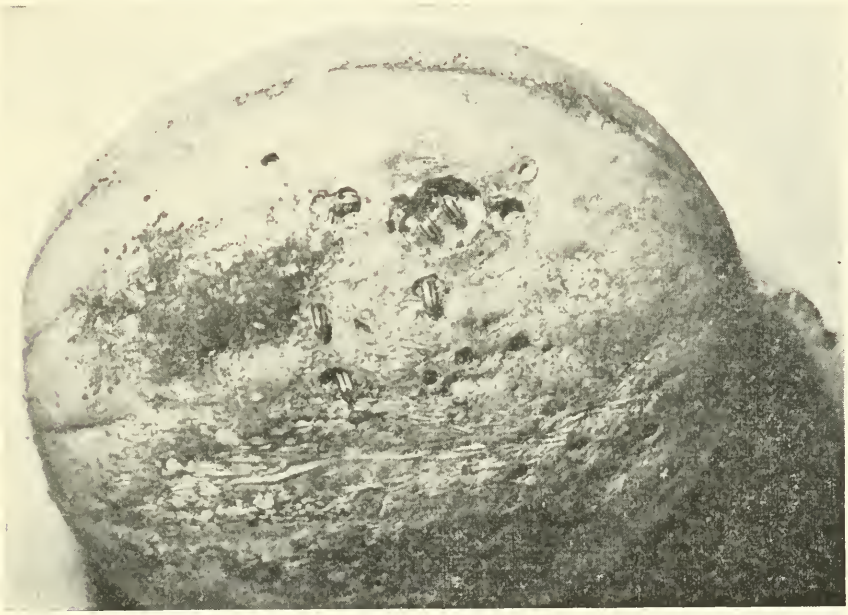

Figure 6. Striped cucumber beetles attacking over-ripe melons.

Strawberry Root Worm.—Following an inquiry on August 8, 1940, from the horticultural inspector at Billings, a strawberry planting west of that city was examined for insects. About 20 per cent of the several hundred plants in this field were dead. The root system of the dead plants had suffered from the feeding of some insect, while leaves of many living and dead plants had been riddled by a chewing insect. Examination of the soil under the dead plants revealed many small white grubs (about one-sixth inch long), numerous pupae, and several small coppery beetles. Most of these adults had four rather irregular, but distinct, black

blotches on the wing covers. These specimens proved to be stages of the strawberry rootworm (*Paria canella* (Fabr.)) previously unreported from Montana. A search in three additional strawberry patches in this area revealed this pest in two of the three plantings.

According to Essig[1] these insects overwinter as adults in the soil, coming out in April and May to feed and deposit eggs on or near the strawberry plants. Larvae hatch from these eggs in seven to fifteen days and feed on the strawberry roots. While Essig notes two generations per year in California, adult emergence dates in the latitude of Billings would suggest a single generation.

When adults are feeding in the spring and autumn, spraying with four pounds lead arsenate to 100 gallons of water gives good control, although this remedy cannot be applied close to picking time. At such periods the plants may be dusted with a mixture of sulfur and ground derris root, containing one per cent rotenone when applied to the plants.

Red Turnip Beetle.—The red turnip beetle (*Entomoscelis adonidis* (Pallas)) is a moderately large beetle, about one-third of an inch in length. In shape it somewhat resembles the Colorado potato beetle, but it is predominantly red with dark areas on the head and pronotum, and three dark stripes on the wing covers. It feeds at night on cabbages, radishes, turnips, and other related plants. Its range extends from Europe through Siberia into the northern part of North America. Although it has been found in the Bridger Mountains, Glacier Park, and at Lombard, it was not reported as injurious until the summer of 1940, when it damaged gardens in and around White Sulphur Springs. It should be controlled easily by the use of usual stomach poisons such as lead arsenate.

Soft-winged Flower Beetle.—This little beetle (*Malachius aeneus* (L.)) was first found in Montana at Bozeman in the spring of 1938 and in 1940 it was not uncommon; a specimen was taken in Madison County near Pony, in the summer of 1940. It is about one-fifth of an inch long, most of the head and prothorax, a V-shaped area including about two-thirds of the elytral suture, the under parts, and the appendages are an irridescent greenish black. The face, the prothorax laterally, and the most of the elytra are deep red. The species was identified by Mr. H. S. Barber of the Bureau of Entomology and Plant Quarantine who submitted the following statement:

"Such a large, conspicuous and abundant exotic species, spreading across our wheat areas, should have received some attention, but except for records of capture in a few places, there seems to be very little information which I can find. It is abundant in

[1]Essig, E. O., Insects of Western North America, 1926, pp. 468-469.

Europe and was reported in New England about 85 years ago, but the only biological notes I find seem based upon the old note by Perris 1852 describing the predatory larva. There is, however, a little-known report that the adults feed upon the soft parts of blossoms of wheat and much reduce the number of kernels formed in a head of wheat, the injury being noticeable only by feeling the ripened heads between the fingers to detect absence of kernels.

"The role of this species in the United States should be determined by new observations on its habits, both as the phytophagous adults and as the predatory larvae."

Alfalfa Weevil.—There are several old records of the alfalfa weevil (*Phytonomus posticus* (Gyll.)) in the State. They were collected from hay shipped into Montana from 1912 to 1914 at Ballantine, Billings, Butte, and Great Falls. In 1938 and 1939 scouts for the Bureau of Entomology and Plant Quarantine collected a few larvae in the vicinity of Wyola. This is the only place in the State where these insects apparently have been established.

Sugar Beet Webworm.—Only light to moderate infestations of the sugar beet webworm (*Loxostege sticticalis* L.) were reported during 1939 and 1940. A heavy moth flight took place over most of the State during early June 1939, but due to the high per cent of sterility among the females few eggs were laid. Moderate infestations necessitating spraying were reported from the vicinity of Fromberg and also from the lower Flathead district near Ronan. Relatively few fields were attacked and damage was slight. In 1940 the moth flight was considerably smaller than during the previous year. The only report of numbers sufficient to require spraying was from the vicinity of Valier. A few fields in the Billings district were reported infested, but not in sufficient numbers to warrant spraying.

Alfalfa Semi-Looper.—This looping, aerial cutworm (*Autographa californica* (Speyer)) was last abundant throughout the State in 1914. The only other record of the species until this year was from Twin Bridges in 1922. In 1940 larvae were reported from alfalfa fields near Helena, Logan, and Ronan, and a large number of adults were flying at Bozeman during the first part of June. The larvae are cutworm-like, but move with a looping motion similar to measuring worms. They are very general feeders, but the most of their damage has been reported from alfalfa. As a usual thing they are so thoroughly held in check by parasites and disease that they are not injurious to crops.

Army Worm.—The true army worm (*Cirphis unipuncta* (Haw.)) appeared in 1940 in a small area south of Scobey. This insect may be a very serious enemy of many crops, especially grasses, but in Montana it becomes sufficiently abundant to do damage only on rare occasions. It may be held in check by the use of grasshopper bait or barriers placed before migrating bands.

Pale Western Cutworm.—The State has experienced several years now with no outbreak of the pale western cutworm (*Agrotis orthogonia* Morr.). It was last important in the spring of 1937. The abundance of this pest is dependent on the rainfall during May, June, and July of the previous year, and it is possible to predict in advance the areas where injury may be expected. Weather data for the spring of 1940 would indicate that it may be a minor pest during 1941 in the Yellowstone Valley from Forsyth to Livingston, and in Golden Valley, Musselshell, central Liberty, southern Lewis and Clark, and Beaverhead counties. Control measures for this insect have been discussed recently[1] and will not be repeated here.

Codling Moth.—In the apple districts of western Montana the codling moth (*Carpocapsa pomonella* (L.)) increased markedly in 1940 over any previous year. Average catches of moths in bait traps went as high as 75.8 for a two-day period. For the first time this pest became sufficiently abundant in the Bitter Root and parts of the Flathead Valley to become one of the foremost problems of the apple orchardist. Conditions during June, July, and August were ideal, and even with good spraying programs the loss was fairly high. However, properly executed spraying programs very decidedly paid for themselves even under conditions of a short crop. The use of bait traps for the collection of adults as an indication of the timing of the cover sprays is becoming more important, and investigations into their use are being continued by Mr. Wm. R. Forsyth, graduate assistant, who was stationed in the area in 1940.

Termites.—Two species of termites have been found in Montana, the damp wood termite (*Zootermposis nevadensis* (Hagen)) which has been collected near Hamilton and doubtless has a wider distribution west of the Divide, and the barren-land subterranean termite (*Reticulitermes tibialis* (Banks)). This latter species (figure 7) is widespread in the State and occasionally damages buildings. It has been collected in or near the following cities in Montana: Billings, Hardin, Havre, Helena, Jefferson Island, Kalispell, Miles City, Powderville, Terry, and Whitehall. The workers, soldiers, and wingless sexual forms are found in tunnels in wood which have been excavated by the workers. This species is not a major pest in the State, but occasionally it is extremely injurious in dwellings. Its presence is usually first noticed because of a buckling or the appearance of holes in the floor, or the swarming of slate-colored winged adults in the rooms. Houses as far north as Havre have been attacked by this insect. Much has been published on the control of the termite and on the prevention of its entrance into houses. Information can be obtained by writing to the Montana Agricul-

[1]Mont. Agr. Exp. Sta. Bul. 366, p. 22, 1939; Mont. Ext. Ser. Bul. 176, p. 16, 1939.

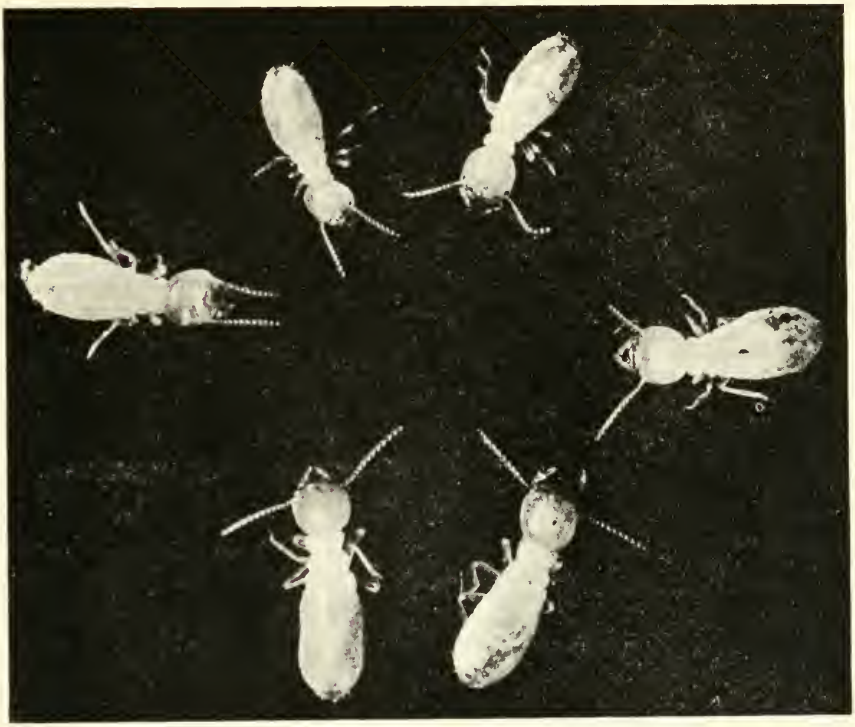

Figure 7. Workers of the termite *Reticulitermes tibialis* Banks. Enlarged 7 times.

tural Experiment Station or to the Office of Information, Department of Agriculture, Washington, D. C.

Alpine Rock Crawler.—Continued search during 1939 and 1940 for this alpine insect (*Grylloblatta campodeiformis* Walker) has yielded some interesting negative and positive collection data. Attempts to collect Grylloblattids in the Bridger Range (Gallatin County) on August 21, September 2, and September 10, 1939, were unsuccessful. Specimens were found in the same general area on September 24, 1939. After the onset of cool autumn weather, accompanied by fall showers, many specimens have been collected in the Gallatin and Springhill canyons. In the Gallatin Canyon on October 11, as well as in the Springhill area on October 17, 1940, a pair of mating adults was found.

Earwigs.—There are no native earwigs in Montana, but two species have been introduced. The little earwig, *Labia minor* L., has been collected twice in or near Bozeman on widely separated dates, and is of little economic importance. In 1939 the European

earwig, *Forficula auricularia* L., was first reported from the State when specimens were collected at Thompson Falls, (figure 8). The abundance of this pest when first discovered would indicate that it had been present for some time previous to 1939. In 1940 an infestation was reported from Lewistown, with the note that these insects had been present for at least six years in this area.

The European earwig is an elongate, shiny brown insect, and is easily identified by the large slender pinchers which are appended to the tip of the abdomen. It is primarily nocturnal in its habits, hiding beneath bark, chips, and other debris during the day. Our infestations undoubtedly came from the introduction of this pest into Pacific ports some time ago. It is abundant in parts of Washington, Oregon, California, and Idaho to the west.

Figure 8. European earwig. Male on left, female on right. Enlarged 5 times.

This insect may be best controlled by the use of poisoned bait. The bait recommended by the Oregon Agricultural Experiment Station, which has worked satisfactorily, consists of

Bran	12 lbs.
Sodium fluosilicate	1 lb.
Fish oil	1 qt.

The dry materials should be thoroughly mixed together and the fish oil added and mixed in. No water is necessary. Sodium fluoride, barium fluosilicate, or paris green may be substituted for the sodium fluosilicate, but they are not so satisfactory. The bait should be scattered about fences, piles of boards, wood piles, trees, and other places where the earwigs may hide. It should be kept away from children. Chickens and other birds would have to eat a great deal of it to be injured.

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