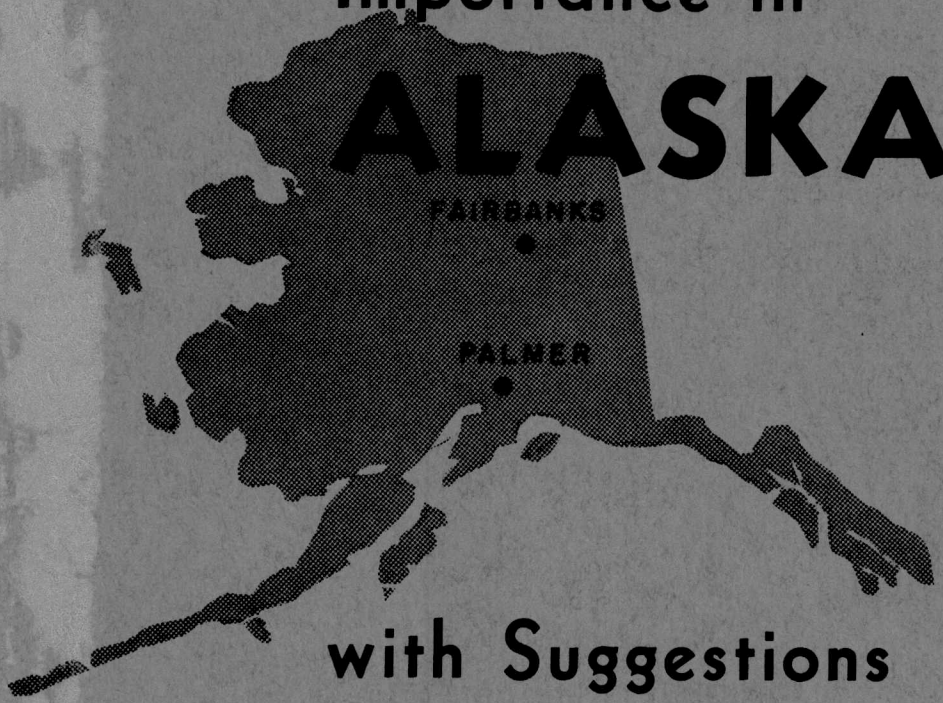
INSECTS

of Agricultural and Household Importance in

ALASKA



with Suggestions for their Control

Alaska Agricultural Experiment Station
Circular 9

Agricultural Research Administration
U. S. DEPARTMENT OF AGRICULTURE

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UNITED STATES DEPARTMENT OF AGRICULTURE

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By

JOSEPH C. CHAMBERLIN

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PREFACE

In Alaska, as in every other agricultural area of the world, insect pests compete in many ways with the farmer for the fruit of his labors. Under certain conditions many plants may be killed or consumed outright. More frequently the developing plants are weakened or stunted so that yields are reduced or quality is impaired. Insects also transmit and spread many diseases to which crops are subject. Finally, the mere presence of insects in or on the harvested crops, or the persistence of injuries inflicted earlier, reduces or destroys the quality and marketability of the product.

Alaskan farmers and gardeners are fortunate that the number of insects injurious to their agriculture is at present very limited. However, as agriculture develops, as crops are diversified and expanded, and as quality standards rise, more and more insects are likely to become of economic importance, and thus require the application of improved methods of control.

INSECTS OF AGRICULTURAL AND HOUSEHOLD IMPORTANCE IN ALASKA WITH SUGGESTIONS FOR THEIR CONTROL[1]

By JOSEPH C. CHAMBERLIN, *entomologist prepared when employed by the Alaska Agricultural Experiment Station, in cooperation with the Office of Experiment Stations and the Bureau of Entomology and Plant Quarantine, Agricultural Research Administration*

Contents

[1] This report is based upon investigations in the Matanuska Valley during the years 1943–45, under the provisions of a cooperative agreement between the Bureau of Entomology and Plant Quarantine and the University of Alaska Agricultural Experiment Station. The field work was financed by the Experiment Station under the administration of Lorin T. Oldroyd. The research work was done under the auspices of the Division of Truck Crop and Garden Insect Investigations of the Bureau. Thanks are due to L. S. Henderson, Division of Insects Affecting Man and Animals of the Bureau for assistance in preparing the section on Household and Stored Product Insects. Information on the life history and control of some of the insects was taken from literature.

INTRODUCTION

Fewer than a dozen species of insects present a serious threat to farm crops in Alaska. Chief among these are the various root maggots that annually infest and damage cole crops throughout the Territory. Cutworms are not uncommon and in outbreak numbers may be even more destructive than the root maggots, as was the case in the Matanuska Valley during 1943. Cutworms, fortunately, are kept in check largely by natural enemies. Hence they are able to build up destructive populations only occasionally when natural checks become ineffective. Wireworms sporadically cause severe damage to potatoes in the Homer, Matanuska Valley, and Tanana Valley districts, and their ravages may become even more important in the future. In southeastern Alaska spittlebugs and slugs cause considerable trouble, but these insects are not found in other sections of the Territory.

Among the insects responsible for minor or sporadic damage is the red turnip beetle, which severely infested cruciferous crops at Circle City in 1944; the striped flea beetle, which feeds upon the foliage of turnips, radishes, and other cole crops and which has done some damage in the Tanana Valley; the garden springtail, which occasionally does considerable injury to newly germinating crops at Matanuska and probably elsewhere in Alaska; the clover mite, which may destroy many annual plants at Matanuska; and a raspberry fruitworm which is the cause of wormy raspberries in many parts of the Territory. Aphids, or plant lice, are also occasionally abundant on ornamental, house, and greenhouse plants in Alaska. Although many species of aphids occur in the Territory, none have yet been found in injurious numbers on field or truck crops.

Insects of household importance, in Alaska as elsewhere, include species which are specially adapted to life in dwellings of mankind. Unlike the agricultural pests, which are for the most part native, these insects are widely distributed in many parts of the world. Among them are such notorious pests as cockroaches, silverfish, clothes moths, dermestids or carpet and upholstery beetles, spider beetles, the sawtoothed grain beetle, the Mediterranean flour moth, and the bean

weevil. Because they live in protected places, these insects are able to persist and multiply in spite of rigorous climatic conditions. They are among our most important pests, and cause much damage every year.

This circular discusses briefly the more important insects of agricultural and household importance in Alaska. As far as possible, suggestions for the control or alleviation of these pests are also given. It is to be borne in mind, however, that our present knowledge of insect pests in Alaska is limited. Until adequate investigations of these pests under Alaskan field conditions can be made, all that can be done in the way of control recommendations is to suggest measures which have proved effective in other parts of the country.

During the last few years enormous strides have been made in the development of new synthetic insecticides. Among these materials are DDT, benzene hexachloride, hexaethyl tetraphosphate, and chlordane. Some of them are more effective against certain insects than the older insecticides such as pyrethrum, rotenone, nicotine, and the various arsenicals, but minimum effective dosages and other limitations to their usefulness are not so well known. It will be several years, however, before fully tested and definite recommendations can be given. Hence, specific advice should be sought from recognized entomologists before an attempt is made to use unfamiliar insecticides. Many insecticide companies now employ entomologists, who can be relied upon to give satisfactory service in this regard, at least for their own products.

PRECAUTIONS TO BE TAKEN WITH INSECTICIDES

Most chemicals used as insecticides are poisonous to man and other animals and should be handled accordingly. When mixing or applying insecticides take special care not to inhale excessive quantities at any time. Well-designed respirators that afford protection to the entire face are available; therefore, use these when such danger exists. Take extreme care to keep the materials out of the mouth and eyes and away from tender parts of the body. When spraying or dusting operations are long and continuous, keep the body well covered even in the warmest weather. After working with insecticides, wash the hands or any exposed parts of the body thoroughly. Residues should not be permitted to accumulate on clothing. To avoid this the clothing used in handling or applying insecticides should be washed frequently.

Containers in which insecticides are kept or stored should be plainly labeled and placed under lock and key, or at least out of the reach of inexperienced persons or children. Receptacles in which insecticides have been mixed should be cleaned immediately. Discarded containers or insecticides should be burned or buried at least 1 foot below the soil surface and away from water supply or drainage.

In addition to the above precautions leather gloves should be worn in mixing and applying poisoned baits by hand. These baits and containers in which they have been mixed should not be left where children or livestock have access to them. Experience, however, has shown that if the poisoned baits mentioned herein are pre-

pared and scattered lightly in the field according to directions their use will not be hazardous to domestic animals, poultry, or wildlife.

Unless the poison residues can and will be removed by washing or stripping, do not apply to the crop any spray, dust, solution, or bait that contains such materials as paris green, calcium arsenate, cryolite, sodium fluosilicate, DDT, benzene hexachloride, or chlordane, when foliage or fruit that is intended to be eaten is on the plants.

Apply all insecticides as sparingly as is consistent with the control of the insect that is being combated. When dusting or spraying, make every effort to apply a light, even coating. Avoid unnecessarily heavy applications.

Oil solutions should not be sprayed near open fires as they are inflammable.

COMMON AND SCIENTIFIC NAMES OF IMPORTANT INSECTS

The insects are referred to by the common name whenever one is available and both the common name and the scientific name are given for specific identification:

Alfalfa aphid	*Macrosiphum creelii* Davis
Apple fruit moth	*Argyresthia conjugella* Zell.
Apple grain aphid	*Rhopalosiphum prunifoliae* (Fitch)
Armed springtail	*Achorutes armatus* (Nicolet)
Bean weevil	*Acanthoscelides obtectus* (Say)
Bedbug	*Cimex lectularius* L.
Black army cutworm	*Actebia fennica* (Tausch)
Blueberry fruit sawfly	*Pristophora* sp.
Bronze apple tree weevil	*Magdalis aenescens* Lec.
Cabbage curculio	*Ceutorhynchus rapae* Gyll.
Cabbage maggot	*Hylemya brassicae* (Bouché)
Cadelle	*Tenebroides mauritanicus* (L.)
Carpenter ant	*Camponotus herculeanus* var. *whymperi* Forel
Carrion beetle	*Silpha opaca* L.
Carrot rust fly	*Psila rosae* (L.)
Celery root fly	*Chilosia chrysochlamys* Will.
Clover mite	*Bryobia praetiosa* Koch.
Codling moth	*Carpocapsa pomonella* (L.)
Cranberry leafhopper	*Cuerna septentrionalis* (Walk.)
Death-watch beetle	*Hadrobregmus destructor* Fisher
Delphinium aphid	*Kikimia* sp. (near *K. wahinkae Hottes*)
Dog flea	*Ctenocephalides canis* (Curt.)
Drug-store beetle	*Stegobium paniceum* (L.)
Firebrat	*Thermobia domestica* (Pack.)
Fireweed hornworm	*Celerio gallii* (Rott.)
Garden springtail	*Bourletiella hortensis* (Fitch)
German cockroach	*Blatella germanica* (L.)
Glassy cutworm	*Crymodes devastator* (Brace)
Green peach aphid	*Myzus persicae* (Sulz.)
Greenhouse whitefly	*Trialeurodes vaporariorum* (Westw.)
Hide beetle	*Dermestes maculatus* Deg.
House fly	*Musca domestica* L.
Larger cabinet beetle	*Trogoderma versicolor* (Creutz.)
Little house fly	*Fannia canicularis* (L.)
Meadow sawfly	*Dolerus* sp.
Meadow spittlebug	*Philaenus leucophthalmus* (L.)
Mediterranean flour moth	*Ephestia kuhniella* Zell.
Onion maggot	*Hylemya antiqua* (Meig.)
Pea weevil	*Bruchus pisorum* (L.)

Potato aphid	*Macrosiphum solanifolii* (Ashm.)
Raspberry aphids	*Amphorophora rubi* Kalt., *A. rubicola* (Oestl.)
Raspberry sawfly	*Priophorus rubivorus* (Roh.)
Red flour beetle	*Tribolium castaneum* Hbst.
Red-tailed tachina fly	*Winthemia quadripustulata* (F.)
Red turnip beetle	*Entomoscelis americana* Brown
Redbacked cutworm	*Euxoa ochrogaster* (Guen.)
Rice weevil	*Sitophilus oryza* (L.)
Saw-toothed grain beetle	*Oryzaephilus surinamensis* (L.)
Seed-corn maggot	*Hylemya cilicrura* (Rond.)
Spinach leaf miner	*Pegomya hyoscyami* Panz.
Spinach webworm	*Gnorimoschema chenopodiella* Busck.
Spotted cutworm	*Amathes c-nigrum* (L.)
Squash root maggot	*Muscina assimilis* (Fall.)
Striped cutworm	*Euxoa tessellata* (Harr.)
Striped flea beetle	*Phyllotreta striolata* (*vittata*) (F.)
True garden slug	*Derocerus agrestis* (L.)
Turnip aphid	*Rhopalosiphum pseudobrassicae* (Davis)
Turnip maggot	*Hylemya floralis* (Fall.)
W-marked cutworm	*Spaelotis clandestina* (Harr.)
Waterlily beetles	*Donacia hirticollis* Kby. *D. dubia* Schaeff.
Webbing clothes moth	*Tineola biselliella* Hum.
Western grape rootworm	*Adoxus obscurus* (L.)
Wheat stem maggot	*Meromyza* sp.
Yellow mealworm	*Tenebrio molitor* L.

CUTWORMS

Alaskan Species

The term "cutworm" is applied to many related species that have essentially similar food habits. Cutworms are the immature, or larval, stage of the moths known popularly as millers.[2]

Many Alaskan cutworms are now known, but only a few are important from the standpoint of crop damage. On the basis of information thus far available, the most widespread and destructive Alaskan species is the red-backed cutworm (figs. 1 and 2), which, with the help of its close relative and associate, the striped cutworm (fig. 3), seems to be responsible for most of the cutworm damage in Alaska. The glassy cutworm (fig. 4) is common in the Matanuska Valley, and may cause considerable damage under certain conditions. The spotted cutworm (fig. 5) is also common and does some damage, especially

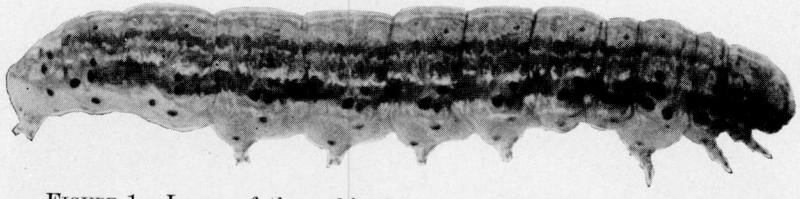

Figure 1.—Larva of the red-backed cutworm. Twice natural size. (Furnished by the Canada Department of Agriculture.)

[2] Moths of the family Phalaenidae (formerly Noctuidae).

in greenhouses or in early spring plantings. Other cutworms of known economic importance, including the w-marked cutworm and the black army cutworm also occur, sometimes commonly, but none have thus far been definitely identified or associated in their larval stages with actual crop damage.

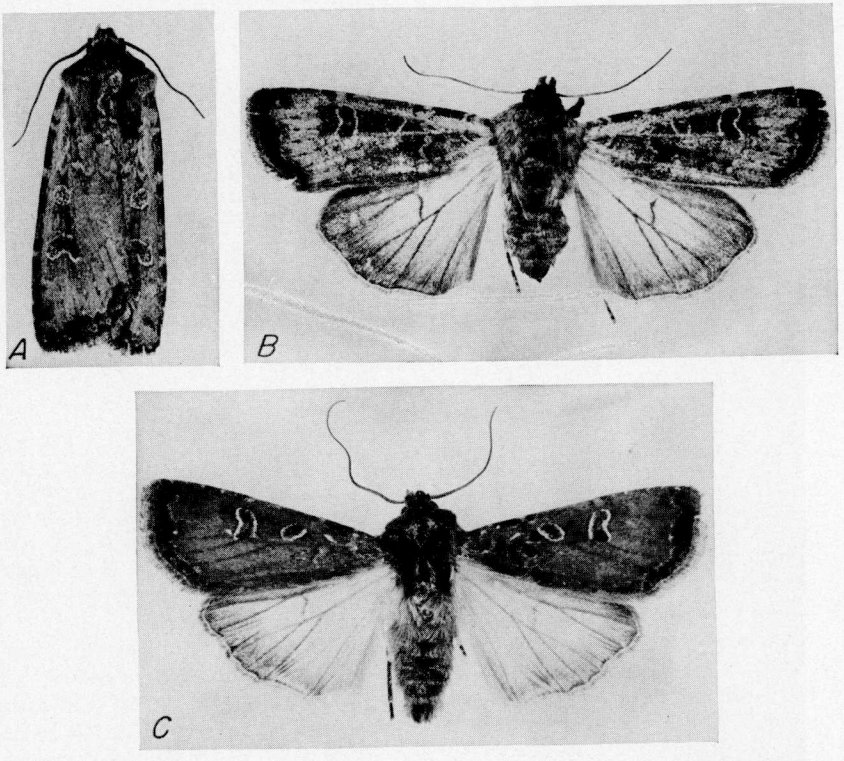

FIGURE 2.—Adults of the red-backed cutworm: *A*, In resting position; *B* and *C*, with wings spread to show variations in markings. Twice natural size. (Photographed by J. C. Garman.)

FIGUE 3.—Larva of the striped cutworm. About three times natural size.

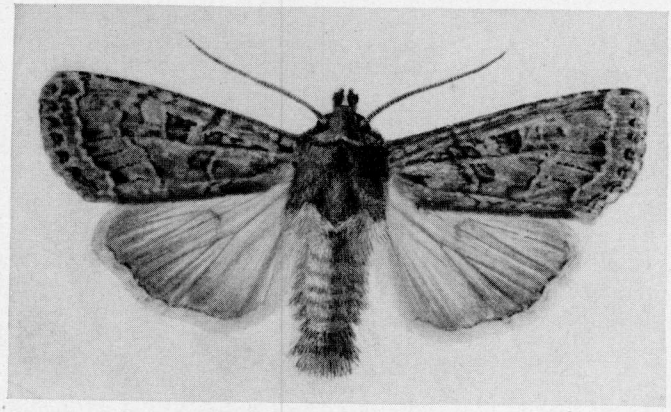

FIGURE 4.—Adult of the glassy cutworm. About twice natural size.

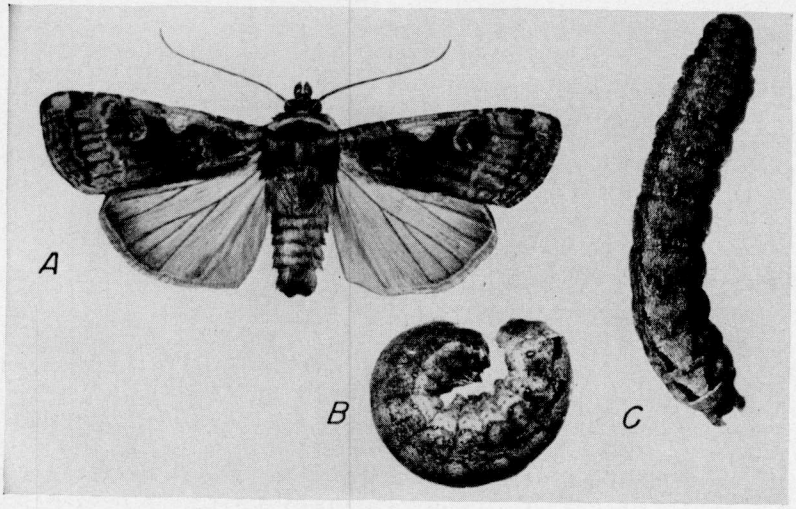

FIGURE 5.—The spotted cutworm: *A*, Adult; *B* and *C*, *larvae*. About twice natural size.

NATURE OF DAMAGE

All cutworm damage is done by the "worm" or larva. The adults feed on nectar, and are important only as the progenitors of the next season's crop of worms. In more southern latitudes many species of cutworms have several generations each year, but in Alaska all species apparently have only one. Injury by cutworms is mostly done in the spring and early summer, when plants are young and succulent. A few species, however, are abundant during middle or late summer, especially in northern latitudes.

As their popular name indicates, cutworms have a habit of cutting off plants near or a little below the surface of the ground, especially when plants are small. Frequently the young plant is drawn partly

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into the burrow of the feeding larva. An examination of the soil near the base of damaged plants usually reveals the cutworm coiled up just below the surface. Not all cutworms behave in this manner, however; some feed almost entirely above ground upon the aerial parts of the plants.

When cutworms are excessively abundant, they will attack anything green and succulent. During such outbreaks some kinds assume a migratory, or "marching," habit and are commonly known as armyworms. Such infestations are capable of denuding whole fields and, unless precautions are taken, making it necessary to replant a second, or even a third, time before a crop can be obtained. This was true at Matanuska during the 1943 outbreak.

Food-Plant Preferences

Cutworms are rather general feeders. They do have decided food preferences, however. Some species such as the glassy cutworm and its relatives, prefer certain grasses. Hence these forms are important in newly plowed and planted sod land, where they feed upon the cultivated crop only because their favored food plant has been destroyed by the plowing. Others, such as the climbing cutworms, prefer native shrubs and trees, only rarely becoming pests of cultivated crops. Still others prefer succulent annual plants such as most weeds and garden vegetables. Such species, although often present in small numbers in uncultivated areas, find agricultural conditions especially favorable for their development, since in the cultivated crops and accompanying annual weeds they possess an especially abundant and suitable food supply.

Life History

All species of cutworms pass through the same developmental stages—egg, larva or caterpillar, pupa, and adult. The duration and seasonal occurrence of these stages differ, often markedly, from species to species. Eggs of the red-backed cutworm are deposited in or on the soil, especially that which has been loosened by a heavy growth of large weeds. Eggs of the striped cutworm are said to be dropped on the surface of the ground around the roots of grass and other herbage. The eggs of the spotted cutworm are apparently laid on or near favorable food plants. The egg-laying habits of the other species concerned are not definitely known.

The eggs may be deposited singly or in clusters. They may be scattered in crevices or under clods of dirt in open fields, or attached to the leaves or stems of weeds, grasses, shrubs, trees, and other plants. The time of egg laying also varies greatly in the different species and localities.

Upon hatching, the small first-stage larvae enter the soil from which they emerge at night or on dull days to feed. Some kinds, however, remain and feed underground throughout their larval period, only rarely appearing on the soil surface or aerial parts of the food plant. In this stage the larvae do little obvious damage, but as they grow larger they become extremely voracious and destructive.

Full-grown cutworms are smooth (nearly hairless) and often greasy

or shiny in appearance. Most of them are well camouflaged, being inconspicuously marked and closely matching the soil or debris in which they hide during the day. The glassy cutworm and its close relatives have dark heads with pale glassy, or somewhat translucent bodies—hence the popular name. These forms almost always feed underground. Cutworms are usually nocturnal in habit. When there is overcrowding or lack of food, however, they may feed or migrate by day as well as by night.

When a cutworm becomes full-grown, it enters the ground and makes an earthen cell in which it changes to a brownish or dull reddish pupa. The duration of the pupal stage varies in the different species but generally averages 3 to 4 weeks, except in those forms which overwinter in this stage. This period is critical in the life of the insect. The pupa is to all appearances almost completely inactive and helpless, being protected only by the earthen cell and its concealed position. Internally, however, great physiological activity is taking place, for the larval tissues and organs are being broken down and completely reorganized into the adult structures. It is only necessary to recall how vastly a cutworm differs from the adult moth to understand how profound this reorganization must be.

The adult moths, or millers, of the various species are similar in general appearance, the color being most often shades of gray, brown, or red. The front pair of wings are usually more or less mottled and crossed with four or five irregular dark lines. In addition, each forewing bears two characteristic marks—one nearer the body and about halfway down the wing, being round or orbicular, and the other nearer the tip of the wing, being larger and kidney-shaped. Cutworm moths measure from 1¼ to 1¾ inches across when the wings are spread. When at rest the wings lie folded flat over the body. The moths are primarily nocturnal in habit and are seldom seen in the daytime. In the early evening, however, they fly about in search of the nectar of flowers. They are often attracted to lights and in consequence sometimes enter houses in large numbers.

Some cutworms overwinter in the egg stage, others as larvae in various stages of growth, some as pupae, while a few spend the winter as adults. All important Alaskan species overwinter in either the egg or the larval stage.

Seasonal Sequence of Important Cutworms in the Matanuska Valley

Adults of the spotted cutworm are found in flight from mid-June to late July or early August, those of the red-backed and striped cutworms from late July to late September or early October, those of the w-marked cutworm from mid-June to late August, and those of the glassy cutworm from early July to late August. Adults of the black army cutworm have been taken only in the fall. It is during these periods that eggs are deposited.

The eggs of the spotted cutworm hatch within a week to 10 days, and the young larvae start feeding immediately. They are about one-third to one-half grown by late fall and pass the winter in this stage. The striped cutworm is also reported to pass the winter in the larval stage, but at Matanuska it apparently overwinters in the egg stage. The red-backed cutworm passes the winter in the egg stage. It seems

probable that the glassy cutworm and the w-marked cutworm also overwinter either as eggs or as very small larvae.

Early in the spring the overwintered eggs hatch, and the larvae begin to feed on the newly sprouting vegetation. The overwintered larvae of the spotted cutworm and others with similar habits resume feeding early in the spring, as soon as food plants become available. The larvae of the spotted cutworm are full grown and ready for pupation by mid-May to early June. Larvae of other species hatched in the spring grow rapidly, reaching a destructive size by late May to early June and maturing from late June to late July, at which time they enter pupation.

Natural Enemies

Cutworms, in Alaska as elsewhere, are preyed upon or parasitized by many species of insects and other animals. They are also affected by diseases of various kinds. In addition, unfavorable weather conditions, such as unusual cold or excessive rain, may reduce their numbers. The effects of these natural controls are very great, and the percentage of insects that survive from egg to adult, is usually very small indeed.

The basic explanation of the cyclical nature of outbreaks is to be found in the relationship of the cutworms to climatic or seasonal conditions, crop practices, parasites, predators, and to the availability of other hosts upon which such parasites and predators can maintain themselves during periods when cutworms are scarce.

Although the subject is complex, it can be pointed out that under normal conditions cutworm populations are held at a low level by the combined effects of various natural control factors. Severe outbreaks result when one or more of these restrictive factors become inoperative or greatly reduced in efficiency. All cutworms have a very high reproductive capacity, and theoretically outbreaks could appear every year (assuming an adequate food supply) were it not for these natural checks.

Economic Importance of Alaskan Cutworms With Reference to Control Practices

The red-backed cutworm and its close relative, the striped cutworm, are similar in appearance and habits under Alaskan conditions. They frequently occur together, although the red-backed species is by far the more common. This species is, with little doubt, the most widespread and destructive cutworm in Alaska. It holds a similar status in neighboring Canada. Larvae of both species develop early in the spring, generally before cultivated crops are planted or growing. They reach their most voracious and destructive stage when garden and truck-crop plants are small and most susceptible. At this time they are about one-third to one-half grown. Their favored food plants include most of the broad-leaved annual weeds, nearly all truck crops, peas, and vetch. They avoid and rarely injure grain unless their preferred food plants are lacking. Potatoes are seldom seriously injured even under outbreak conditions, no doubt owing to the recuperative power of the potato rather than to its lack of palatability. The

red-backed and striped cutworms, as well as some other species, prefer to feed on lambsquarters, chickweed, and other succulent weeds. In potato fields, during the 1943 outbreak at Matanuska, cutworms actually did more good than harm, because they almost eliminated the weeds without severely damaging the potatoes.

Both the red-backed and striped cutworms usually feed underground. Under outbreak conditions, however, they come freely to the surface and may assume an armyworm habit. In general, they can be controlled with poison baits, although their tendency to feed underground makes this method of control more difficult than is the case with some other species. Soil treatment with DDT should be especially useful in combating these species.

The glassy cutworm feeds entirely underground, primarily in grass or pasture land. Where such land is plowed, the larvae present will survive for long periods and will then feed upon whatever crop is grown there, including all varieties of vegetables. Under such conditions this species may cause serious damage. Since they do not come to the surface to feed, they cannot be controlled with poison baits. Soil treatments with DDT, however, may prove effective against this species.

The spotted cutworm is one of the commonest species at Matanuska, but it does not seem to do much damage there. In many other sections of the United States it is one of the most destructive cutworms. The reason for its minor economic status at Matanuska is that it is single-brooded and overwinters in the larval stage. The overwintered larvae, in large part, mature and pupate before most garden and field plantings are up. Their only opportunity to damage garden and field crops therefore comes in unusually early plantings.

The spotted cutworm is occasionally troublesome in greenhouses where it may be accidentally introduced in infested soil early in the season. Its food plants include most garden and field crops as well as most annual weeds. At Matanuska it is especially common in clover and alfalfa fields and in patches of chickweed and lambsquarters. When abundant the spotted cutworm assumes the armyworm habit of migration and is capable of doing great damage. It is a surface and foliage-feeding species, and is easily controlled with poison baits.

The w-marked cutworm, although common at Matanuska and elsewhere in Alaska, is not yet definitely known to feed on cultivated crops in damaging numbers. It is destructive in other regions however, and may under certain conditions be destructive in Alaska as well. It is a climbing cutworm, ascending small trees and shrubs to feed upon their buds and tender leaves. Under outbreak conditions it affects many vegetable, field, and small fruit crops, including raspberries, and currants. It is readily controlled with poison baits.

The black army cutworm was found only in small numbers at Matanuska during the years 1943–45. However, it is of considerable economic importance in parts of Canada and in the northern United States. When abundant it may assume the armyworm habit of migrating in large swarms. Its favored food plants are various trees and shrubs, including blueberries, but it also feeds readily upon

legumes and many garden vegetables. It may be effectively controlled by poison baits.

Recommended Practices for Cutworm Control

Until recent years, at least, cutworms have been controlled almost entirely with poison baits, artificial barriers of various kinds, and by cultural methods. With the advent of DDT, however, new practices, depending upon the contact action of the insecticide, have become feasible. The use of DDT or of other new insecticides with similar properties may ultimately render baits obsolete or of restricted usefulness. Until such time, however, as the value of DDT as a contact insecticide has been more thoroughly explored under a wide variety of conditions and against a large number of species, it seems inadvisable to eliminate bait recommendations from a cutworm-control program.

SOIL TREATMENT WITH DDT

Cutworms, like most caterpillars, are very susceptible to DDT. Experiments conducted on a small scale at Matanuska during 1944 showed that radishes grown in soil, the top inch or so of which had been treated with a DDT dust were almost completely protected against injury by the red-backed cutworm. The efficacy of this insecticide has also been observed by William C. Cook at Walla Walla, Wash. He reports that 2 pounds of technical DDT per acre has given nearly complete crop protection against cutworms. The DDT was applied as a dust or spray and lightly raked or harrowed into the top inch of soil at the time the seedbed was prepared. The cutworm, in burrowing or hiding in the top soil would contact enough DDT particles to cause death.

One application of 5 percent DDT dust at 40 pounds per acre (equal to 1 pound per 1,000 square feet) with any device that will distribute it evenly over the soil surface will give protection for the entire season. For small gardens an ordinary hand duster is suitable, but for larger acreages a power-dusting unit, a lime spreader, or some other mechanical device will be required.

***Caution.*—See precautions on pages 3–4.**

POISON BAITS

When to apply.—In combating infestations of cutworms for which poison baits are effective, timeliness of application is of great importance. Cutworms are usually present and active in the soil at the time the earliest plantings are made. Hence, it is often advisable to broadcast the poison bait over the ground just before planting is done. Whether or not this is worth while can generally be determined by examining the soil for the worms. One effective method is to distribute small and compact piles of succulent green food plants, such as clover, chickweed, or lambsquarters (pigweed), over the bare ground and allow it to remain 2 or 3 days. If cutworms are present, they will be found congregated under these piles or in the adjacent soil.

Composition.—Suitable cutworm baits may be purchased already prepared, or they may be mixed at home if desired. Wheat bran is

remarkably attractive to many species of cutworms and they feed on it even in preference to green vegetation. It is therefore preferred to other materials in most cutworm baits. Sometimes, however, shorts have been found to be slightly more attractive.

Many recommended cutworm baits include sweetening, such as molasses, and some also contain crushed fruits, particularly oranges or lemons. There is no good evidence that the addition of crushed fruits, or even molasses or sugar, increases either the attractiveness or the effectiveness of baits.

The following formula should give good results with those species against which baits are effective:

Wheat bran, dry, flaky	25 pounds
Sodium fluosilicate	1 pound
Water enough to moisten	3 to 4 gallons

If sodium fluosilicate is not available, paris green, white arsenic, or sodium arsenite may be substituted. Lead arsenate is not effective in cutworm baits.

How to mix.—The bran and poison should first be thoroughly mixed dry and then gradually moistened with water and again thoroughly mixed, until all the bran is damp. A half barrel or watertight box makes a good receptacle in which to mix small quantities of bait. The quantity of water to be used depends upon the character of the bran. The bran should crumble readily upon being squeezed in the hand, for a sticky bait is hard to distribute.

***Caution.*—Follow carefully the precautions given on pages 3–4.**

Application.—Cutworm baits are generally broadcast over the infested areas at the approximate rate of 10 or 12 pounds per acre, although applications up to 20 pounds per acre may be desirable when infestations are very heavy. For small gardens a 20-pound dosage would probably be best. This is equivalent to about one-half pound of bait per 1,000 square feet.

If possible, the bait should be distributed several days before transplants are set out. This application should be made late in the evening, so that the bait may be fresh and moist when cutworms become active. Care should be taken not to throw the bait upon the plants or against the stems, since some burning may result. The bait will withstand a light shower, but heavy rains destroy its effectiveness. One to three rebaitings at intervals of 4 to 10 days may be required to bring severe infestations under control.

DITCHES AND BARRIERS FOR COMBATING MIGRATING CUTWORMS

Baited ditches.—When cutworms migrate in large numbers from land in which they have developed to neighboring fields, a combination of ditches and poison bait may be used to good advantage.

Vertical-sided ditches are used for moist soil and dusty-sided ditches for dry soil. To prepare a vertical-sided ditch the furrow is thrown away from the field to be protected, and it may be necessary to deepen the furrow by running the plow through a second time, throwing the soil the same way as at first. A colter is used to make the edge of the furrow as sharp and vertical as possible, and this margin may require

reshaping with a spade. To make a dusty-sided ditch a deep furrow is plowed with the earth thrown toward the field to be protected, and a log is dragged up and down this furrow, preferably soon after plowing, until the soil on the sides of the furrow is so loose and fine that cutworms have great difficulty in climbing out.

It is usually not advisable to construct the ditches so that they will in themselves form permanent barriers against traveling cutworms. Their main purpose should be to halt the cutworms temporarily so that they may be induced to feed upon poison bait or poisoned vegetation scattered in the ditch. Unless checked in this way, marching cutworms will sometimes pass over the bait without feeding. If many cutworms cross the first ditch, it may be necessary to make a second one some distance beyond the first, and the second ditch should receive an application of poison bait or of 5 percent DDT dust when cutworms begin to collect therein.

Protective collars or cylindrical bands.—Collars or cylindrical bands of tar paper or tin are sometimes employed to protect individual plants from cutworm attack. If properly applied, they are reasonably effective against some species of cutworms, but they are generally too costly of labor for large-scale use.

FIELD SANITATION PRACTICES

Weed control.—Weedy areas, such as neglected edges of fields, stump rows, and other waste areas, are favorable for the oviposition and development of cutworms, and should therefore be eliminated.

Avoidance of newly turned sod land.—Glassy cutworms and related sod- and grass-infesting species cannot be controlled by means of poison baits. Damage from these species generally results when their favored food plants have been eliminated and they are forced to feed upon such crop plants as may be available. Valuable vegetable or similar crops should therefore not be planted on or adjacent to newly turned sod or grassland.

Spring plowing.—Cutworms develop more slowly in plowed fields than in places where an abundant supply of food is available. For this reason, in fields plowed early in the spring they continue to cause damage for some time after cutworms of the same species in neighboring unplowed fields have become mature and ceased feeding. Late-spring plowing thus tends to bring cutworms to the end of their destructive period at an earlier date. Moreover, the remaining cutworms are not confined entirely to the crops for food, but feed largely upon the weeds and other plants recently turned under by the plow.

Miscellaneous cultural practices.—Some practices that are helpful in reducing cutworm populations in other areas cannot be advised for use in Alaska. For example, late-fall plowing to destroy the insects or expose their hibernating stages to the weather and other natural enemies cannot be recommended for the Matanuska Valley because of the danger of wind erosion. Similarly, late-summer fallow or midsummer plowing, as a means of inhibiting the oviposition of certain species, cannot be practiced because of the shortness of the growing season.

ROOT MAGGOTS

Alaskan Root Maggots and Their Food-Plant Preferences

Root maggots are the most injurious crop pests with which the Alaskan farmer or gardener has to contend. They appear in damaging numbers on many varieties of cole crops (including cabbage, cauliflower, rutabaga, turnip, and radish) throughout the Territory wherever farming or gardening has been attempted. Unlike cutworms, they are present every year, and their ravages are familiar to every Alaskan grower.

The term "root maggot" is applied to a group of insects which commonly feed upon the roots of their favored host plants. They are the larval stages of small gray flies [3] similar in appearance to the common house fly. Two species of root maggots are numerous in the Matanuska Valley and probably throughout Alaska.

The most important Alaskan species is the turnip maggot, which infests and damages nearly all plants of the mustard family. It is closely similar in its habits to the cabbage maggot which has not been reported in the Territory.

The second important Alaskan species is the seed-corn maggot (fig. 6), which is abundant in the Matanuska Valley, Homer, and other coastal sections. It has not yet been definitely recorded from the interior of Alaska. The seed-corn maggot is a more general feeder than the turnip maggot. In addition to the cole crops, it may also damage newly germinated seedlings of many sorts, including such common garden vegetables as beans and peas. Under certain conditions it may also infest the leafy top growth of such plants as spinach; however, such infestations have not yet been observed in Alaska. In some sections of the northern and eastern United States it is also an important pest of potato seed pieces. Such infestations weaken the developing plant and largely destroy its productive capacity. Infestations of seed-corn maggots on potatoes have been observed at Matanuska, and in 1944 one fair-sized field was damaged to such an extent that it was abandoned. This species is able to develop in dead organic matter, such as cottonseed meal, fish meal, and other organic fertilizers.

A third species of root maggot, the onion maggot is also found in Alaska but apparently has not been able to establish and maintain itself through the winter. This species works only in the roots and bulbs of onions and related plants. It has been frequently introduced into the Territory, mostly in infested onion sets. A very light infestation was seen at Circle Hot Springs in 1945, and similar ones have been reported from other parts of Alaska. It does not appear that the onion maggot will be an important pest under Alaskan conditions, except possibly in the southeastern section.

Occasionally other vegetables, particularly carrots, have been reported to be infested with root maggots, but no verification of such reports has as yet come to hand. The larva of the carrot rust fly, while not a true root maggot, infests the roots of carrots in parts of the United States and Canada, and it would not be surprising if this insect should eventually be found in Alaska.

[3] Family Muscidae, subfamily Anthomyiinae; mostly of the genus *Hylemya*.

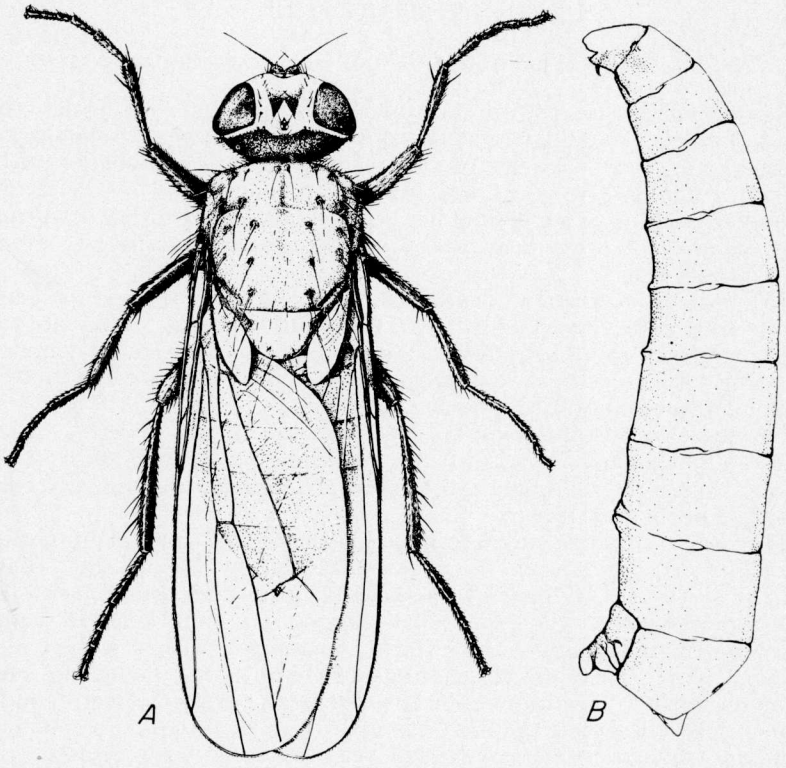

FIGURE 6.—Seed-corn maggot. *A*, Adult female (16 times natural size); *B*, larva (19 times natural size).

LIFE HISTORY AND SEASONAL DEVELOPMENT

This account refers particularly to the turnip maggot and the seed-corn maggot. The life histories of these two species are similar but differ in details.

The eggs of both species are small, white, and roughly cylindrical or narrowly oval. Those of the turnip maggot are laid in small clusters on the base of the main stem and upon the exposed taproot of their favored food plants. When abundant the egg masses are easily seen on the basal parts of the plant and adjacent soil. The seed-corn maggot, which is less restricted in its food habits, deposits its eggs more or less generally over the soil surface, in crevices under small clods, and in similar places.

The eggs hatch in 2 to 10 days, depending upon the temperature. The average duration of the egg period in Alaska is not known, but is probably 5 to 7 days or more because of low average temperatures.

Upon hatching, the young larvae, or maggots, enter the soil and start feeding on the roots of the food plants. As the infestation develops and the maggots grow, they tunnel into the root tissues themselves, especially of turnips and radishes.

The maggots mature approximately 4 weeks after hatching. They are whitish to pale yellow and slender. They have no legs or other appendages and move by squirming. When mature they are four-sixteenths to five-sixteenths inch long. Upon attaining their full growth, they usually leave the roots and enter the soil nearby for pupation. Some, however, may pupate in the tunneled portions of the infested roots. Pupae may be found as deep as 9 inches in the soil, but most will be in the top 2 to 4 inches. The puparium, or hardened skin of the last larval stage in which pupation occurs, is seedlike, light to dark reddish brown, narrowly oval, and approximately three-sixteenths to four-sixteenths inch long.

The pupae remain inactive in the soil for a varying period depending on locality and climatic conditions. As with cutworms, the tissues are reorganized into the adult structures during the apparently quiescent, pupal stage.

In southern latitudes there are frequently several, sometimes many, generations of root maggots each season, but in the Matanuska Valley and inland sections of Alaska there is but one annual generation. The pupae hibernate in the soil until the following spring and early summer.

With the coming of warm weather the adults emerge from the pupae and crawl to the soil surface. They are now small, grayish flies, similar in general appearance to the ordinary housefly. There are no easily recognized differences between the two species, although the adult turnip maggot (as well as the onion maggot) is distinctly larger than the seed-corn maggot. Like cutworms, the adults do no direct damage and are important only as the progenitors of the next generation. The adult fly of either sex lives for about 4 to 9 days. After mating the female matures, deposits her quota of eggs, and soon dies.

Seasonal Sequences at Matanuska

Observations on the seasonal history of the turnip and seed-corn maggots are lacking for Alaskan localities other than the Matanuska Valley. It is probable, however, that the seasonal picture differs only in detail from one section to another.

Adults of both species start emerging from the overwintering pupae by the last of May or early part of June. They do not emerge all at once, but over a 5- to 6-week period, mostly during the latter half of June. The rate decreases thenceforward and terminates about mid-July.

At Matanuska egg laying starts during late May to early June, depending upon the earliness of the season, and continues until mid-July at least. The eggs hatch in a week to 10 days. Thenceforward until mid-July both eggs and larvae may be found in the field. By the latter half of July some of the larvae will have completed their development and may be found in the pupal stage. From this time until frost both larvae and pupae, but not eggs, are abundant in infested gardens. The proportion of pupae to larvae gradually increases until fall, when the last maturing larvae pupate and disappear. Overwintering takes place in the pupal stage only.

Natural Enemies

Only a few parasitic insects were reared from root maggots in Alaska, and neither they nor predatory insects were sufficiently common to reduce maggot numbers to a noneconomic level. Root maggot parasites include the small parasitic wasps *Trybliographa rapae* (Westwood) and *Phygadeuon niger* (Ashm.). Only *P. niger*, however, was definitely reared from parasitized pupae at Matanuska. A species of parasitic fly of the family Larvaevoridae (Tachinidae) was also reared in small numbers from root maggot pupae, but the species has not yet been identified. Adverse climatic conditions are probably the principal checks to root maggot abundance in Alaska.

Nature and Severity of Damage

As already noted, root maggot infestations of cole crops in Alaska have been known in all areas, however remote, ever since gardening has been attempted in the Territory. The history of such infestations has always been essentially the same. For the first year or two following the breaking of isolated new ground, root maggots are either rare or absent, but within 2 or 3 years wormy radishes, turnips, and other susceptible crops are invariably reported. From then on more or less serious infestations are present every year. This phenomenon indicates that at least one economically important species of root maggot, probably the turnip maggot, is indigenous to Alaska and will be found in small numbers on wild hosts everywhere. The introduction of agriculture merely offers a new and abundant food supply of which the insect takes quick advantage.

Home gardens, which are fixed in location and are not often included in systematic crop-rotation practices, are more seriously infested than are field crops, except where the latter are grown year after year in the same or closely adjacent ground. Under such conditions infestations become progressively worse until it is almost impossible to grow susceptible crops. One such garden, which was sampled at the Matanuska Experiment Station in 1944, produced turnip maggot adults at a rate in excess of three quarters of a million per acre and seed-corn maggot adults at a rate exceeding a quarter of a million per acre.

While feeding upon the roots of plants, the root maggots destroy the tissues of the cambium layer, often completely girdling the roots or stems, and ultimately killing the host. The water-conducting vessels, however, may remain intact for a considerable period, and so the plant may remain green and apparently alive for a long time after the injury is actually complete. One of the most distinctive symptoms of root maggot injury to cole crops is the red and yellow coloration of the basal or outer leaves.

The root injuries inflicted by the feeding maggots permit various fungus and bacterial diseases to gain entrance, and thus cause the roots to decay. In addition, injured plants are often infested with tiny wingless insects, known as springtails (Collembola) and by very tiny root-feeding mites (Acarina). Both aggravate the injury already started by the maggots.

Infested plants not killed outright are badly dwarfed or stunted (fig. 7). Cabbage, cauliflower, and other plants having edible tops

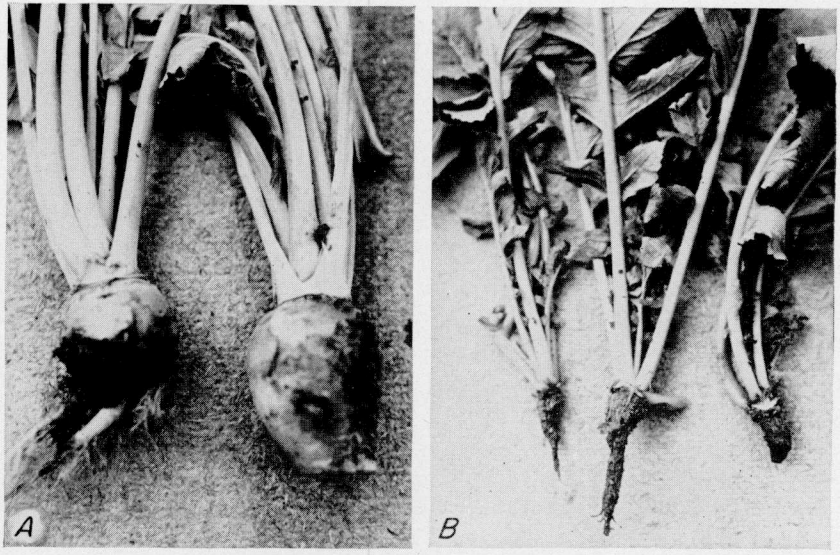

FIGURE 7.—Root maggot injury to plants grown at Matanuska, Alaska: *A*, To rutabaga roots; *B*, to roots of winter radish. (Photographed by Stanley Balloun.)

have a markedly reduced yield, the heads usually being premature and often very small. Even light infestations may cause serious deformation of root vegetables, such as radishes and turnips. In any event, the roots are so scarred or riddled with maggot burrows and accompanying decay that they are unfit for market and scarcely usable for food, even at home.

The seed-corn maggot is sometimes a serious pest of potatoes, infesting and feeding upon the newly planted seed pieces (fig. 8). Nonsuberized or damaged seed pieces are the only ones readily infested. Once infested, they may be consumed in whole or in part, and such plants as may develop are weak, spindly, and nonproductive. Maggots are also incidentally responsible for the transmittal of various potato diseases, particularly blackleg.

PLANT RESISTANCE TO ROOT MAGGOT DAMAGE

Although all cole crops are susceptible to root maggot injury, some varieties are more susceptible than others.

Cauliflower is in general much more severely affected than is cabbage, while broccoli, kohlrabi, and brussels sprouts seem to be less easily damaged then either. Both turnips and radishes seem to be especially susceptible to injury, although some of the yellow turnips, such as the Petrowski and Golden Ball varieties in particular, seem to show considerable resistance. Rutabagas are quite susceptible to maggot infestation but often seem to show pronounced recuperative powers. Lightly or moderately infested rutabagas often show little injury at harvest, except scars and distortion resulting from earlier injuries. These facts hold great promise for the future, since they

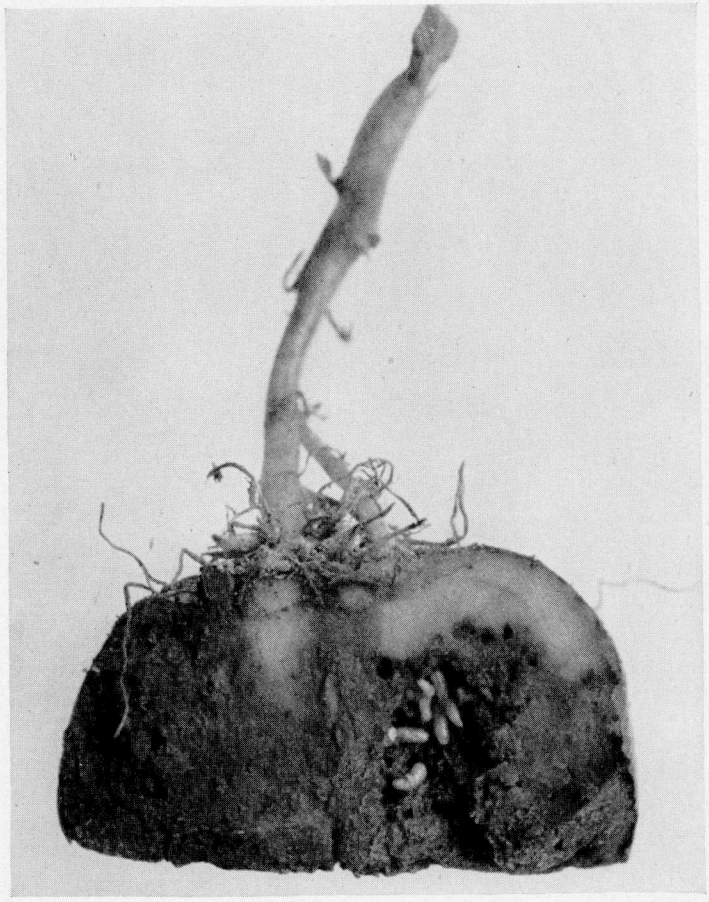

FIGURE 8.—Potato seed piece showing larvae and typical feeding tunnels of the seed-corn maggot. About natural size.

definitely point to the possibility that maggot-resistant varieties of many cole crops might be developed by a well-planned plant-breeding program.

SUGGESTIONS FOR CONTROL ON COLE CROPS

Turnip and seed-corn maggots on the leafy cole crops and to some extent on radishes, may usually be controlled by corrosive sublimate solutions or calomel suspensions. Where infestations are excessively high, or where most root crops are involved, no really effective method of control is known. Tar paper disks may be employed on cabbage, cauliflower, and other leafy cole crops with fair success, but not on root crops.

Many materials, including DDT, have been tested for root-maggot control during the last few years, but corrosive sublimate and calomel are still the most effective known materials for this purpose.

CORROSIVE SUBLIMATE AND CALOMEL

Where corrosive sublimate (mercury bichloride) or calomel (mercurous chloride) is used in root-maggot control the recommended strength is 1 ounce of the finely powdered crystals to 10 gallons of water. Corrosive sublimate, being very insoluble, should be dissolved in about a pint of hot water before cold water is added. Calomel is almost insoluble in water. Hence, soap chips or some other wetting agent must be added to make a suspension, which should be kept agitated when in use to prevent settling. When calomel is used, it is sometimes helpful to coat the seeds with the crystals at the time of planting. Corrosive sublimate should not be so employed, since it retards the germination of the seeds.

***Caution.*—Corrosive sublimate is very poisonous to human beings and all farm animals; it should therefore be used with great care. It is also very corrosive to metal; therefore, metal containers should be thoroughly rinsed after use.**

Methods and time of application.—About one-half cupful of solution should be applied close to the base of each plant at the time of transplanting, care should be taken to avoid wetting the leaves. For seedbeds or root crops about 1 gallon of solution is required for each 35 feet of row shortly after the plants are up, and more for later applications when the plants are larger. The soil should be wet to a depth of about one-fourth inch. Trom two to four applications, a week to 10 days apart should be made.

The solution may be applied to a few plants with a sprinkling can from which the sprinkling rose has been removed, or with a pail and dipper. More rapid application can be made from a knapsack or barrel spray tank equipped with a short hose, a 2-foot extension rod, and a pinchcock or other valve, the liquid being allowed to run by gravity to the base of each plant.

TAR-PAPER DISKS

Effective control of root maggots can usually be accomplished for all except root crops by close-fitting tar-paper or light roofing-paper disks. These disks should be not less than 4 inches in diameter. They may be purchased, or made at home. The finished disk is fitted collarlike around the stem of the plant. It should fit snugly and rest firmly on the smoothed soil surface. The upper surface of the disk must be kept free from soil. The purpose of the disk is to inhibit the deposition of eggs and to prevent newly hatched larvae from crawling down the stem and into the soil around the taproot.

When paper disks are used to supplement the corrosive sublimate or calomel treatments, the solution is applied at the time of transplanting, before the disks are set in place. The disks obviate the necessity of subsequent treatments.

Crop Rotation and Other Agronomic Practices to Reduce Turnip Maggot Damage

CROP ROTATION

Crop rotation will not control root maggots, but it is a very helpful practice, especially when used as an adjunct to regular control

methods. When susceptible crops are properly rotated, light to moderate infestations may appear, but severe ones are rare.

Crop rotation should include kitchen and home gardens wherever possible. Commercial plantings of all cole crops should be grown on fresh land each year, preferably as far as possible from the previous years' plantings of susceptible crops.

Root crops, in particular, are capable of producing enormous fly populations, for two reasons: First, the number of plants per acre is higher than for such crops as cabbage and cauliflower; second, their fleshy roots provide a more abundant and suitable food supply for the maggots. Hence, it is important to avoid planting turnips and rutabagas in the same soil year after year, and it is especially important to avoid following such crops with more valuable plants such as cabbage and cauliflower.

FIELD SANITATION

It is extremely doubtful that fall or early spring plowing for exposing maggot pupae to the weather or other natural enemies would significantly reduce fly populations. On the other hand, much good may be accomplished by removing and destroying the maggot-infested stalks and taproots of cauliflower and cabbage, as well as infested root crops such as turnips and rutabagas. If left in the field through the winter, such roots harbor large numbers of pupae. Woody and partially decayed stalks may be burned and the fleshy roots of turnips and rutabagas, if not too severely infested and decayed, may be fed to livestock. Severely injured or killed plants should also be removed and destroyed at periodic intervals during the growing season.

ELIMINATION OF WILD MUSTARDS

The turnip maggot and to some extent the seed-corn maggot develop on wild plants of the mustard family. Elimination of the field mustard, which is common in parts of the Matanuska Valley and elsewhere, will help in reducing fly populations.

TIME OF PLANTING

It has been suggested that by unusually early or late planting, damage from root maggots may be avoided or minimized. Where the maggots are single-brooded, as in Alaska, this practice is moderately effective, especially with very quickly maturing crops, such as radishes and some varieties of turnips. For most of the leafy crops, however, Alaskan seasons are too short to make the practice effective. Adults of the root maggot are present about the time most garden plants are coming through the ground and continuously thereafter, although in diminishing numbers, throughout June and much of July.

Rutabagas may usually be grown if planted during late June or early July. However, this may result in reduced yields. The same is true of turnips and particularly radishes. Since no economical artificial control for maggots on root crops is known, late planting is recommended as a means of avoiding maximum damage, even though yields may be sacrificed to some extent.

THICK STANDS TO SECURE PROFITABLE YIELDS

A common practice is to grow unusually heavy stands of maggot-susceptible crops early in the season. The stands may be gradually thinned by removing and destroying infested plants. When an excess is grown, enough noninfested or only slightly infested plants will remain to produce a profitable yield.

Removal and actual destruction of the infested plants, including the roots, is important if best results are to be secured. Otherwise maggots present in the roots of such plants may infest adjacent maggot-free plants.

Suberization of Potato Seed Pieces for Protection Against the Seed-Corn Maggot

The seed-corn maggot has not yet become a serious pest of potatoes in the Matanuska Valley, although it has caused some damage. It is quite possible, however, that such damage may be more general and serious in the future.

Root maggot infestations of potato seed pieces start only on the raw-cut surfaces of the potato, or where the tuber has been injured mechanically or by bacterial and fungus growth. Infestations are also more frequent in soils rich in humus, in soils treated with organic fertilizers, or on ground previously planted to cole crops. Agronomic practices which avoid such conditions will help to prevent this type of injury.

Maggot injury to potato seed pieces can be largely avoided if preventive crop rotation and fertilization practices are adopted; if the seed potatoes are cleanly cut with thin, sharp knives to avoid rough surfaces; if seed pieces are disinfected to kill surface-borne spores of disease and decay organisms; and if the cut surfaces are properly suberized and toughened before planting.[4]

MINOR PESTS OF AGRICULTURE

Aside from the root maggots and cutworms, agricultural crop pests in Alaska are at present of relatively minor importance. In the following account a few of the more important of these are discussed. In order of importance, the principal species or groups would probably be the wireworms, slugs, spittlebugs, the red turnip beetle, a raspberry fruitworm, and springtails. The other groups or species noted would follow in no particular order.

Suggestions for control are given very briefly. Recommended materials can best be secured in stock form from any reputable dealer in insecticidal products. If the manufacturer's recommendations are carefully followed, satisfactory results can generally be assured. Since the mixing of insecticidal dusts, in particular, is difficult, it is usually better to rely upon a commercially prepared product.[5]

[4] Reid, W. J., Jr., Wright, R. C., and Peacock, W. M. Prevention of damage by the seed-corn maggot to potato seed pieces. U. S. Dept. Agr. Tech. Bul. 719, 37 pp., illus. 1940.

[5] Howard, N. F., Weigel, C. A., Smith, C. M., and Steiner, L. F. Insecticides and equipment for controlling insects on fruits and vegetables. U. S. Dept. Agr. Misc. Pub. 526, 52 pp., illus. 1943.

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Slugs and Suggestions for Their Control

GENERAL APPEARANCE AND HABITS

Slugs are terrestrial mollusca more closely related to snails, clams, oysters, and similar animals than to insects. They are all plant feeders and are often important garden pests.

Slugs have soft, elongate, subcylindrical bodies which can be greatly retracted when disturbed or at rest, and greatly extended when moving or feeding. Locomotion is by means of scarcely perceptible undulations of the ventral body surface or "foot." The well-developed head is provided with two pairs of slender, hollow tentacles, the upper pair of which each bears an eye at the tip while the lower pair bear organs of touch and smell. The mouth, which is partly concealed on the underside of the head, is equipped with cutting mandibles bearing irregular rows of small sawlike teeth. The skin is soft, sensitive, and moist, and has numerous glands which secrete a glairy mucous or slime which serves to protect the animals from drying out. Slugs normally exude this slime on objects over which they crawl or glide. Upon drying, the mucous trails remain visible as silvery tracks.

Slugs feed mostly at night. During the day they remain concealed in debris, under boards or stones, in crevices in the soil, or similar hiding places. During dull weather they continue to be active throughout the day.

ABUNDANCE AND ECONOMIC IMPORTANCE

Slugs are most abundant in regions with moderate to cool climate and moderate to abundant rainfall. In Alaska they are common in the coastal areas of the southeastern portion, from Ketchikan to Haines and Skagway. They are rare or absent elsewhere, although one small infestation was noted at Anchorage during 1945. It seems probable that this infestation was introduced in soil around the roots of imported plants. Damage to both vegetable and flower gardens by slugs has been widely reported throughout most of southeastern Alaska, where they may be rated as one of the most troublesome garden pests. Slugs sometimes establish themselves in greenhouses, where they may develop into serious pests unless remedial measures are taken.

Which species are responsible for the slug damage thus far experienced is not certainly known. There are many native species but these, in general, are solitary in habit and rarely important as garden pests. It seems more probable that the true or gray garden slug (fig. 9), a highly gregarious species, is largely responsible. This introduced European species was observed in abundance in gardens and pastures at Haines in 1945. The infestation previously noted at Anchorage was of a different species (*Ariolimax columbianus* (Gould)), which is native to woodland areas in Oregon, Washington, British Columbia, and probably southeastern Alaska. Apparently this second species has not previously been reported as a garden pest.

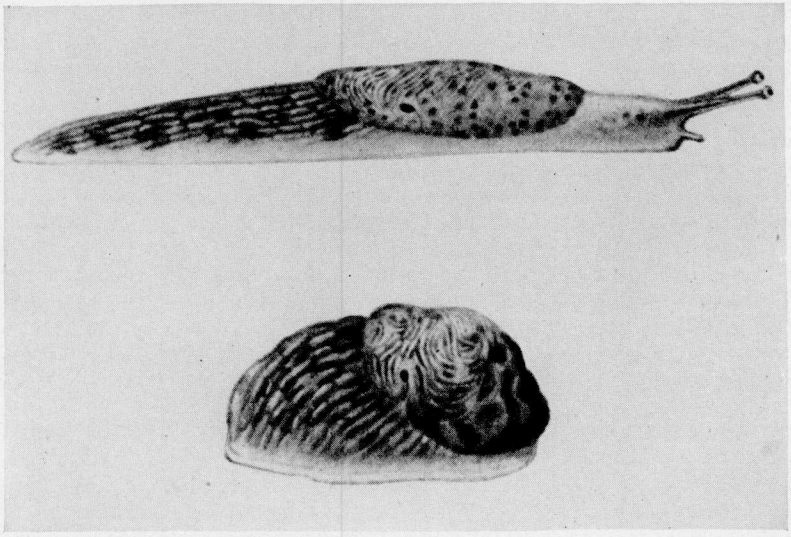

FIGURE 9.—The true garden slug: Above, in extended position; below, contracted. (Furnished by Oregon Agricultural Experiment Station. After Lovett and Black.)

NATURE OF INJURY

Slugs are general feeders and few vegetable or ornamental plants escape attack by them. Leafy vegetables such as lettuce and cabbage are especially subject to injury. The smaller plants are consumed entirely, whereas the leaves are eaten on the larger ones. Slugs are also objectionable because of their habit of hiding in and between the basal leaves of many leafy vegetables. The presence of slugs and their slime trails renders produce objectionable or unsalable, even though the plants are not otherwise seriously injured.

CONTROL

Slugs may be controlled by hand picking if only a few are present. Garden cleanliness will also contribute much toward their control. All loose boards, stones, trash, and similar debris that might offer them shelter should be removed. Crevices in basements and other storage places should be eliminated. Since dampness is favorable to slugs, basements and other storage places should be kept as dry as possible. Chickens and especially ducks feed upon slugs and snails and may sometimes clean up infestations in limited areas.

In Alaska it is probable that the best means of control for slugs will be a metaldehyde-calcium arsenate, pelleted, bran bait. A formula found satisfactory in Oregon is 1½ pounds of metaldehyde and 5 pounds of calcium arsenate to 100 pounds of wheat bran. Metaldehyde is strongly attractive and also poisonous to slugs, but under damp and rainy conditions there may be considerable recovery from metaldehyde poisoning alone; hence calcium arsenate should always be included in baits used under these conditions. In damp weather the bait in pellet form remains effective over longer periods than loose

bait, and it is more economical. An application of 5 to 10 pounds of pelleted bait to an acre is equivalent in effectiveness to an application of from 40 to 50 pounds of nonpelleted bait. It is recommended that only pelleted baits be used in Alaska.

***Caution.*—See precautions on pages 3–4.**

Since the machines employed in pelleting poultry and rabbit foods are costly, it will prove more economical to purchase already pelleted slug baits than to attempt their preparation at home.

Where infestations are severe, or where damage persists beyond the period of initial treatment, the bait should be renewed weekly. Baits should be broadcast as evenly as possible, and best results are secured when applications can be made in fair weather.

Mites (Acarina)

Mites are arachnids rather than insects, being related to such familiar animals as ticks, spiders, and scorpions. They are small to minute, always wingless, and usually eight-legged. There are no distinct divisions of the body into head, thorax, and abdomen, as with the insects. Many mites are parasites; others prey upon small insects and such other animals as they may catch or kill; still others feed only upon dead or upon living plant material. Among mites feeding on living plant material are such important agricultural pests as the red spiders, the cereal and root mites, and the blister or gall mites.

Mites are common in Alaska, but so far only one species seems to be of economic significance. This is the clover mite, a species which belongs to the red spider group.

THE CLOVER MITE

The clover mite is smaller than a pinhead, with very elongate forelegs. It is reddish or rusty brown and more or less globular, and has a soft flexible cuticle. The eggs are deposited in the fall and hatch in the early spring. The mites feed upon foliage of herbaceous plants, trees, and shrubs, infesting the undersides of the leaves. Unlike some related species, the clover mite does not produce a webbing on the infested leaves. In southern localities (California for example) there are several broods annually, but it is doubtful whether there is more than one brood in Alaska.

The clover mite is widespread throughout the northern United States and Canada. Its range extends to the shores of the Arctic Ocean, where it was collected at Bernard Harbor, Canada, and at Camden Bay, Alaska.

At Matanuska the clover mite was observed in considerable numbers in 1944 on chickweed, Dutch clover, nasturtiums, columbine, and other flowering plants. Damage was moderately severe in some places. According to a Matanuska Valley informant, this mite occasionally causes severe damage in flower gardens. It has not yet been reported from other farming areas of the Territory, although undoubtedly it is present in all of them.

The clover mite is a general feeder and has caused injury to apple, peach, prune, plum, pear, cherry, raspberry, various forest trees, and

many kinds of herbaceous plants. Infested plants become yellowish and may even be defoliated.

Lime-sulfur and summer oil sprays are effective in controlling this pest. The recommended strength of lime-sulfur for summer use on green plants is 4 pounds of the dry material, or 1 gallon of the liquid, to 50 gallons of water. Where an oil spray is used, the manufacturer's directions should be closely followed.

Springtails (Collembola)

Springtails are very small to nearly microscopic, globular or elongated, soft-bodied, wingless insects that are generally provided with a special forked springing organ on the under surface of the body by means of which they can leap with great agility for considerable distances. They are often seen in enormous numbers on surfaces of temporary rain or snow pools, and occasionally in great numbers on surfaces of snow fields. On snow fields they are often known as snow fleas.

Most species of springtails are of little or no economic importance, since they feed largely upon decaying vegetable matter and fungi of various kinds. A few, however, feed upon germinating seeds or living plants in fields, gardens, and greenhouses. When abundant in gardens, they often contaminate leafy vegetables, even though no direct feeding injury is caused. Their presence in the heads of such vegetables as lettuce, cabbage, and cauliflower may seriously reduce the grade and value of such crops, especially if they are to be processed for commercial use. They may also transmit various rots and fungi. Of the many species in Alaska, only two or three are of known economic importance.

THE ARMED SPRINGTAIL

The armed springtail is a small oval insect. The young are white whereas the adults vary from dark brown to violet, greenish gray, or dark slate blue.

This species is common at Matanuska and elsewhere in Alaska as well as in the United States, Canada, and other parts of the world. In Alaska it may, no doubt, be found in any garden.

At Matanuska the armed springtail was found commonly infesting maggot-injured roots of cabbage, turnips, and rutabagas, as well as scab injuries on the roots of beets, radishes, and potatoes. It was also found in abundance between the basal outside leaves and, in smaller numbers, in the inner edible portions of mature cabbage. These infestations did not seem to result in serious damage. In some localities the armed springtail is responsible for serious injury to germinating seeds, but no such damage has yet been observed or reported in Alaska.

THE GARDEN SPRINGTAIL

The garden springtail is the outstanding economic species known in Alaska. It is the greatest agricultural pest in this group of insects. It is widespread throughout North America, Europe, Japan, and elsewhere.

The garden springtail is a very small, nearly globular species meas-

uring about one-twentieth inch long. It is dark purplish and spotted with pale yellow. It appears as a very tiny black spot on infested leaves or other objects. When disturbed it disappears almost instantly as the result of a powerful, flealike leap. The young are very similar to the adults except for their smaller size.

When abundant, these insects, in spite of their minute size, can be extremely destructive, especially to newly germinating seedlings. They feed upon the cotyledons and first true leaves, perforating or pitting them with multitudes of tiny pin-point feeding scars, thus stunting or even killing the young plant. Although present throughout the season, they do not cause much injury once the plants are well established.

The garden springtail was observed in damaging numbers in the Matanuska Valley in late May and early June of 1944 and 1945 on seedling radishes, turnips, rutabagas, and alfalfa. Many plants were seriously stunted, and sufficient numbers were killed outright markedly to reduce the stand. The garden springtail was especially injurious to newly germinating radishes throughout the season of 1945 (May to late July), whereas in 1944 it greatly reduced the stand and seriously weakened the remaining plants in an experimental planting of alfalfa. During 1945 it was also found on seedling radishes at Homer in July, on beans and other garden vegetables at College and Fairbanks in June, and on radishes and rutabagas at Circle Hot Springs on June 21. It has not as yet been taken in southeastern Alaska, but is almost certainly there.

The garden springtail may be controlled by dusting the infested plants with lime containing 2 or 3 percent free nicotine.

***Caution.*—See precautions on pages 3–4.**

Spittlebugs, Leafhoppers, and Psyllids

Spittlebugs, leafhoppers, and psyllids are small insects that belong to the order Homoptera, which also includes the aphids or true plant lice. These insects feed only upon the sap or juices of plants, which they obtain by means of a piercing and sucking beak. The nymphs are similar in appearance to the adults except for the absence of wings. There is no pupal stage. The food habits of nymphs and adults are essentially similar. The adults have four wings, which fold closely against the abdomen in a rooflike fashion when not in use. They are all capable of leaping as well as flying, the hind legs being enlarged for this purpose.

Many of our most important agricultural pests belong to these groups of insects. When abundant, they damage crops by sucking the juices from the plants. They are also important vectors or transmitters of plant diseases. Leafhoppers and psyllids, in particular, are common and sometimes abundant in Alaska. At present, however, only a few species are of agricultural importance in the Territory.

SPITTLEBUGS

Spittlebugs or spit bugs were so named because the nymphs are surrounded by a white frothy mass of viscid fluid, which serves as a pro-

tection to the developing insect. Sometimes these frothy, cottonlike masses are so abundant as to disfigure plants over extensive areas.

The only species of spittlebug common in Alaska is the meadow spittlebug (figs. 10 and 11), an introduced European species now found throughout the United States.

It is probably a fairly recent introduction in Alaska. In Oregon and parts of Washington, where it is sometimes known as the strawberry spittlebug, it is a serious pest of strawberries. This species has recently become quite a pest in southeastern Alaska, where it seriously injures flowers and other ornamental plants. It is also abundant on weeds, in meadows, and similar places.

In its adult stage the meadow spittlebug is about one-quarter inch long, less than one-eighth inch broad, generally mottled in appearance, and ranges from a light yellowish brown to nearly black. The body is compact, rather robust, and more or less oval. The head is bluntly rounded and fits closely against the thorax. When the insects are not in flight the closely folded wings, which match the rest of the body in their markings, taper to an abrupt point behind.

There is but one generation annually. The adults emerge in late summer and fall, hibernate through the winter, and deposit their eggs in the early spring. The nymphs appear in the spring and early summer (May to July). Most observed plant injury results from the feeding of the nymphs.

The meadow spittlebug was abundant on various weeds, particularly cow-parsnip and dock, as well as on many flowers and ornamental shrubs at Juneau during August 1945, after most of the nymphs had

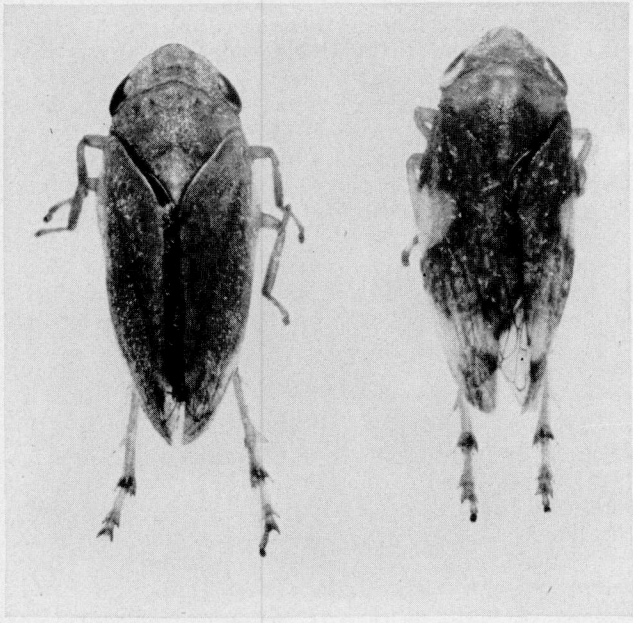

FIGURE 10.—Adults of the meadow spittlebug. About 7½ times natural size. (Photographed by J. C. Garman.)

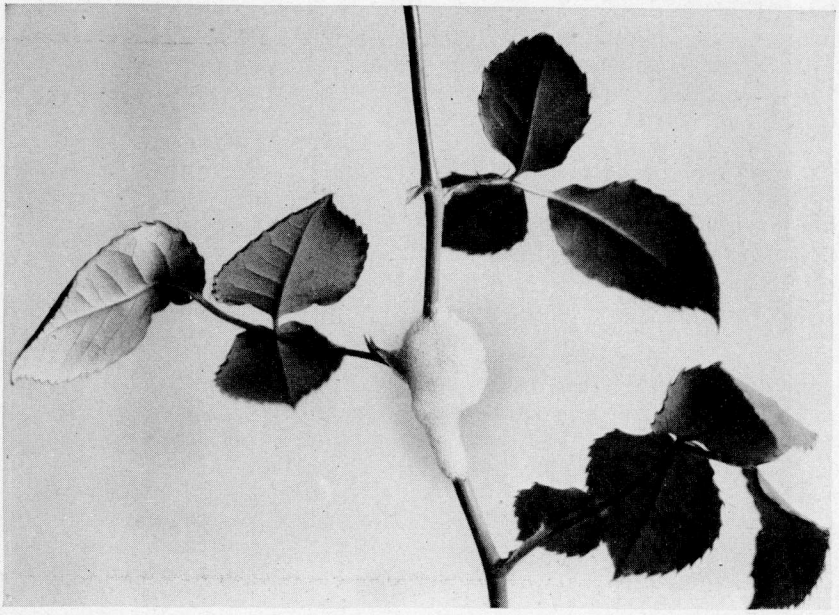

FIGURE 11.—Spittle mass produced by the nymph of the meadow spittlebug on rose.

matured. Adults were also found late in August at Haines, where they were swept from oats and peas, and were also taken on raspberries and thimbleberries. At Haines the insect had only recently become troublesome and seemed to be present in damaging numbers only within the town itself. As far as known at present, the spittlebug is found only in the southeastern coastal sections of Alaska.

Spittlebugs mar the appearance of host plants (especially ornamentals) with the objectionable and conspicuous masses of spittle. They not only sap the vitality of the plants, but often produce various deformations in the leaf and stem structures, apparently owing to the injection of saliva in the course of feeding.

This insect can readily be controlled by treating the frothy masses of spittle with a dust containing 0.5 percent of rotenone. Applications should be made as early as the spittle masses appear on the plants, and good coverage is important.

LEAFHOPPERS

Leafhoppers are small, slender, streamlined insects. The head is broad, generally rounded, and closely fitted to the thorax. From the thorax they taper behind to the tips of the folded wings. The hind legs are enlarged permitting them to leap grasshopper fashion. The front or upper wings are generally colored and marked uniformly with the rest of the body. Adult leafhoppers and spittlebugs are similar in general appearance, although most leafhoppers are smaller.

Leafhoppers of many kinds are common especially in grassland and meadow areas throughout Alaska. Although common, none are of known economic importance to cultivated crops. One species,

however, which may be tentatively termed the cranberry leafhopper was noted in large numbers at College and Fairbanks in 1943. It is a handsome species, being relatively large and almost black with the forewings brightly margined with red. This species was extremely abundant on low-bush cranberries, the foliage of which had been severely damaged by their feeding punctures.

The cranberry leafhopper, while of no present importance, may prove to be a pest should the commercial culture of low-bush cranberries ever be undertaken in areas where it is common.

Leafhoppers may usually be controlled by the application of DDT, pyrethrum-sulfur, or nicotine dusts.

***Caution.*—See precautions given on pages 3–4.**

PSYLLIDS

Of the fairly large number of psyllids, or jumping plant lice, now known from Alaska, only one can be rated as a potential crop pest. This is an unnamed species of the genus *Aphalara* which is tentatively termed the turnip psyllid.

The turnip psyllid is a very tiny, almost gnatlike insect with large transparent but slightly mottled wings, which it holds rooflike over the body when at rest. Under magnification it has the general appearance of a miniature cicada.

Adults of this species were found abundantly infesting cole crops at Fairbanks and College in June 1945. Specimens were also collected in smaller numbers at Circle Hot Springs, Copper Center, Matanuska, and Homer. Turnips seemed to be an especially preferred food plant. Specimens were also commonly found on radishes, rutabagas, mustard, and, in smaller numbers, on cabbage and cauliflower.

The status of the turnip psyllid as a crop pest is not known, although infestations as heavy as those observed at College might be troublesome on small plants. No nymphs were found, and it is uncertain whether they have the same food habits as the adult. If control should be necessary, the same measures recommended for aphids would probably be effective.

Aphids, White Flies, and Mealybugs

Aphids, white flies, and mealybugs are small to very small sucking insects which feed entirely on the sap or cell juices of living plants. Although related to the leafhoppers and psyllids, they differ in being sluggish in movement and often relatively fixed in position on their host plants. White flies (aleurodids) are not native to Alaska, and mealybugs (or other scale insects) are rare. Aphids, on the other hand, are relatively common, a considerable number of species now being known from the Territory.

Aphids, mealybugs, and white flies are among the most destructive and important plant pests. In Alaska, however, none are as yet known to be of more than minor importance.

Insects of these groups while small are often extremely abundant, sometimes being found massed almost solidly on the leaves and stems of their favored food plants. Under such conditions the vitality of

the infested plant is rapidly drained while affected foliage is yellowed and curled or otherwise misshapen. Many of these insects, particularly the aphids, are also responsible for the transmission of the viruses of certain plant diseases.

APHIDS

General characteristics.—Aphids, or plant lice, of many kinds are found in Alaska. Some species are of considerable economic importance in the United States and Canada. They are small, more or less oval insects, with long, slender legs, and antennae. Wings may or may not be present, nearly all species having both winged and wingless forms in the adult stage. The two pairs of wings are delicate and generally transparent. Even in the winged stage aphids are relatively sluggish in their crawling and flight. They vary greatly in color and pattern markings. Many of the common forms are various shades of green, while some are yellow, reddish, brown, or black.

Most species excrete a sweetish fluid, known as honeydew, which often covers the leaves and stems with a glistening varnishlike coating that is much sought after by ants. Molds or other fungi frequently develop in honeydew deposits, giving the affected leaves and stems an objectionable sooty appearance.

Life history.—The life history of aphids is too varied and complex to be adequately discussed here, especially in view of their minor economic importance. It varies greatly from species to species as well as from region to region for the same species. In northern latitudes aphids generally overwinter in the egg stage. The adults developing from these eggs are all females, which reproduce asexually, giving birth to living young. After several generations, often as conditions on the initial host plant become crowded, winged females are produced, which migrate and infest new plants after which reproduction continues. With the coming of fall, both males and females develop. After mating takes place, overwintering eggs are produced and deposited, thus completing the cycle.

Some aphids confine their feeding largely to one or a small group of related host plants. Many others feed and develop on a large variety of plants. Still others alternate their food plants at different times of the year. These alternate hosts may be as different as grasses and apple trees.

Natural control.—Aphids are extremely prolific and capable of developing enormous numbers within a very short time. Fortunately, they are generally held in check by the attacks of many other insects, both parasites and predators, by various fungus diseases, and by the feeding of small birds. Adverse climatic factors also tend to limit their abundance, and many plants possess a natural resistance to their attacks.

The more important natural enemies noted in Alaska include the larvae of many species of syrphid or flower flies, the larvae of various ladybird beetles, tiny parasitic wasps of the families Braconidae and Figitidae, and a fungus, presumably *Empusa aphidis* Hoffm.

These various natural-control factors seem to be especially effective in Alaska. With the exception of a few species, chiefly wild plants of little or no economic importance, few cases of plant injury from aphids

have been seen or reported, except occasionally under greenhouse conditions.

Alaskan aphids of present or potential importance.—Alaskan species of aphids, noted on cultivated hosts or wild hosts of economic importance, include the following.

The apple grain aphid (*Rhopalosiphum prunifoliae* (Fitch)) abundantly infested apple trees at both Juneau and Haines in August 1945. Several of the infestations were severe, causing yellow foliage, curled and distorted leaves, and partial defoliation.

This aphid is a widespread pest of grain, grasses, apples, and other plants in Europe and the United States. In Alaska it is probably largely restricted to the southeastern section.

The turnip aphid was taken at Matanuska only on mustard and shepherds-purse. It is an important pest of cole crops in parts of the United States. It seems to be of no present importance in Alaska.

The potato aphid (fig. 12), a large green species, is widely distributed in Alaska, where it is commonly found on most cultivated herbaceous plants. At Matanuska it was taken on garden and field peas, potatoes, radish, spinach, cauliflower, cabbage, lambsquarters, shepherds-purse, cucumber (in greenhouses), columbine, and wild rose, and it undoubtedly infests many other garden and field crops. It was also found on potatoes, clover, and strawberries at Haines and Homer, and on lambsquarters, strawberries, raspberries, and wild roses at

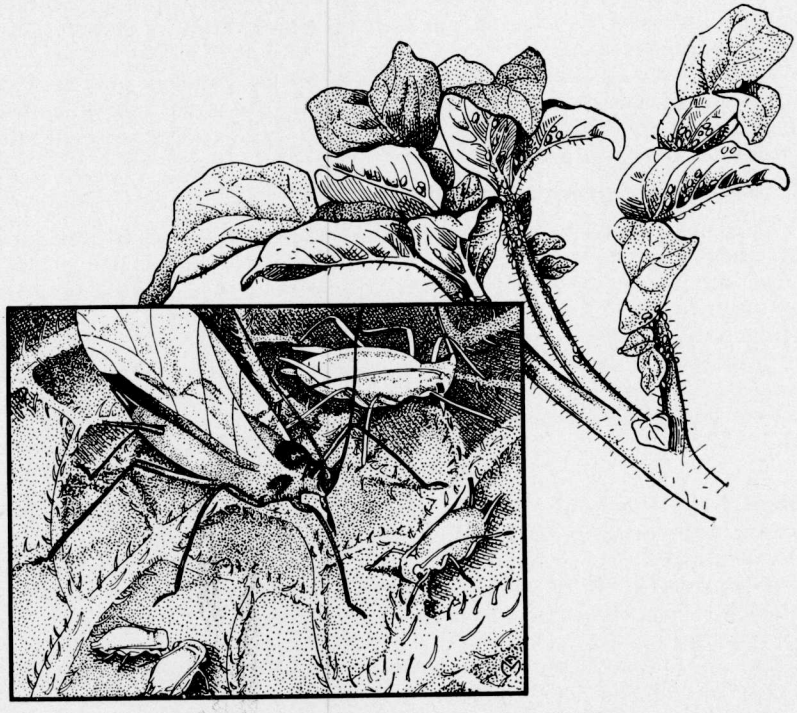

FIGURE 12.—The potato aphid. Much enlarged.

College and Fairbanks. It was never abundant enough to be damaging, however.

The alfalfa aphid was taken in small numbers on both purple- and yellow-blossomed alfalfa at Matanuska. This species is a moderately important pest of alfalfa in western United States.

The green peach aphid is an important economic species in the United States. It was found in small numbers at Fairbanks and in the Matanuska Valley. It is recorded from a large variety of host plants, but it was taken only on radishes in Alaska.

A small black aphid which may be tentatively termed the delphinium aphid is abundant, sometimes in damaging numbers, on cultivated delphiniums in the Matanuska Valley. It was not collected elsewhere.

Two related species of raspberry aphids were found infesting this host in Alaska. No observed infestations were sufficiently severe to cause obvious damage. Infestations were noted and collections taken at College and Fairbanks, in the Matanuska Valley, at Homer, and at Haines. Both species probably appear throughout the Territory wherever their host is found. They also occasionally infest roses. *A. rubicola* is the principal vector of raspberry mosaic disease in the State of Washington.

Damaging aphid infestations of wild roses and wild currants have occasionally been seen, and cultivated varieties of both these plants may also be infested under certain conditions. *Aphis varians* Patch and *Amphoraphora sonchi* (Oestl.) have been reported on currants at Eklutna, and *Kakimia* sp., *Myzus porosus* Sand., and the potato aphid on roses at Matanuska.

Suggestions for control.—Aphids in fields or gardens may be controlled by sprays or dusts containing DDT, rotenone, and nicotine. For small gardens, flower beds, and greenhouses, sprays are generally more effective than dusts.

***Caution.*—See precautions on pages 3–4.**

For house plants infested with aphids, mealybugs, or whiteflies, a soap spray or dip is an effective and easily applied remedy. Soap sprays should not be used on very young or tender plants, and the soap solution should not be permitted to saturate the soil. A satisfactory soap spray can be made by dissolving a cubic inch of bar soap or 2 tablespoonfuls of soap flakes in a quart of water. Thorough application is a requisite to successful aphid control. Only those insects contacted by the insecticide will be killed.

MEALYBUGS

Mealybugs infest all types of vegetation throughout the world. These wingless insects have flattened oval bodies covered with a white waxy secretion. A series of short filaments extend from the sides of the body, those at the tail end being longer and more slender. Owing to the short legs the insects crawl about very slowly.

Only a few species of mealybugs or other scale insects are native to Alaska, and none of the native forms are of economic importance. Certain introduced mealybugs (*Pseudococcus* spp.), however, occasionally appear in damaging numbers on house and greenhouse plants.

They may be controlled or eradicated by use of the same remedies suggested for aphids.

WHITEFLIES

Whiteflies are tiny insects similar to the scale insects and mealybugs, especially in their immature stages. They damage plants by feeding upon the juices, which they extract by means of a slender sucking beak. Whiteflies are especially important in southern regions of Alaska. No native species are known from Alaska. One introduced species, however, the greenhouse whitefly was observed damaging house plants at Anchorage in 1945. The species is a common and troublesome pest in greenhouses and on house plants in many parts of the world.

The greenhouse whitefly is often found in enormous numbers infesting the undersides of the leaves of many varieties of plants. The young insects are oval, thin, very much flattened, and semitransparent, and are sparsely covered with slender, nearly transparent, waxy filaments. They are pale green and scarcely more than one thirty-second of an inch long when full-grown. They move slowly, if at all, appearing to be more or less fixed to the leaf surface. The adults have large, powdery white wings and yellow bodies.

Whiteflies may be controlled by the same methods recommended for aphids.

True Bugs (Hemiptera)

The true bugs, or Hemiptera, constitute a large order of insects that are characterized by a sucking beak and dissimilar wings. The front wings are more or less thickened or leathery in texture at their base but thin and membranous at their tip. The hind wings are membranous throughout. When folded, the hind wings are concealed by the forewings, the membranous tips of which overlap on the back, forming a cross.

Most bugs are plant feeders, and a large number are important agricultural pests. The chinch bug is a well-known example. Others are predatory, feeding largely on other insects, and a few, such as the bedbug, are parasitic and bloodsucking in habit. True bugs are not common in Alaska, and none are known to be of more than very minor economic importance at the present time.

Several species of *Lygus*, or plant bugs are relatively common and widely distributed in Alaska although nowhere have they as yet been observed in damaging numbers. *Lygus campestris* (L.), *L. approximatus* Stal, *L. distinguendus* Reuter, *L. pabulinus* (L.), and *L. shulli* (Knight) have been taken in the Matanuska Valley. These insects feed upon all kinds of weeds, flowers, grasses, and cultivated crops. When abundant they are very destructive. Infested plants turn yellow and are weakened or even killed by severe attacks. When they feed upon the seed balls or seed pods of sugarbeets and alfalfa, these insects greatly reduce the yield of viable seed.

Lygus bugs of all species are rather similar in general appearance, being flattened, almost oval, and about three-sixteenths to five-sixteenths inch long. Their coloration ranges from various shades of green or yellow through brown to nearly black. In addition they are

usually somewhat mottled or spotted, oftentimes with red. The nymphs, which resemble the adults except for the lack of wings, are pale yellow or green.

Lygus bugs may be controlled by heavy applications of a dust containing 5 percent of DDT and 2 percent of oil, or by a pyrethrum-sulfur dust containing 0.2 percent of pyrethrins.

Beetles (Coleoptera)

The beetles, or Coleoptera, are hard-bodied insects of various sizes. The hard and horny forewings fold closely against the abdomen, concealing the membranous hind wings, when not in flight. They have strong, biting jaws, and undergo a complete metamorphosis, the larvae being quite unlike the adult in appearance and often in habit. They pass through a typical pupal stage just as do the cutworms and root maggots. The larvae of beetles are extremely variable in form; some are grublike or wormlike with or without legs; others are flattened or variously formed, adapted to hunting and killing other insects on which they prey.

Beetles vary widely in their food habits. Some are predatory on insects and others on small animals; some are scavengers; and others are strictly vegetarians, feeding on the leaves, stems, or roots of plants. Most of the predatory forms, such as the ground beetles and the lady-bird beetles, are beneficial, since they kill many plant pests. Some of the plant-feeding forms are among our most serious farm and garden pests. Many others are wood-boring in habit, and among these are found many of our most important and destructive forest and timber pests. Still others feed on stored food and other organic products, and are destructive household and stored-products pests.

Beetles of many kinds are abundant in Alaska, over a thousand species having thus far been recorded. Aside from some affecting forest trees and timber, only a few are of economic importance. Only those of some importance as farm or garden pests are included in this discussion.

Silphids, or Carrion Beetles

Silphids are moderately sized to large beetles, most of which feed upon decaying animal or plant matter. They are abundant around the carcasses of dead animals. Most of them are somber-colored with brown or black, although a few are brightly marked with red and orange. A few feed upon living plants and are thus of economic importance as garden pests. One such species is found in Alaska.

One of the carrion beetles, here tentatively termed the vegetable silphid, has been observed doing minor damage to vegetable crops at Matanuska and Circle City.

The adult vegetable silphid is a large, flat, broadly oval, black beetle about one-half inch long. The larvae are narrowly oval, shining black, with a rather hard body wall, which is divided into about a dozen well-marked segments. The head is concealed from above by the thorax, as are the short but well-developed legs. The larvae are active and move rapidly when disturbed. They feed upon the roots and leaves of many vegetables.

At Matanuska larvae of this species were found in small numbers

in the soil, working on young cabbage plants which were cut off—the injury resembling that caused by cutworm feeding. This insect is probably present throughout Alaska but does not seem to be of much importance.

The vegetable silphid may be controlled by the use of poison baits, as are cutworms.

WIREWORMS, OR CLICK BEETLES

Appearance and habits.—Wireworms are the larvae of the click beetles, or snap beetles. Click beetles are objects of interest and curiosity, to most small boys at least, because of their ability to right themselves when turned on their backs by a quick snapping movement of the head and thorax. This act produces a clicking sound; hence their popular name. They are narrowly oval beetles, dull black or brown in color. Some are bicolored and a few are of a metallic green lustre.

The larvae are slender and wormlike, but of a hard, shining, wiry texture. The bodies of wireworms are clearly segmented and are generally yellowish or white. They are all vegetable feeders, many living in the soil and feeding upon the roots of field and garden crops of all kinds. They are among the most troublesome of all insect pests.

Alaskan species.—A considerable number of wireworm species have been collected in Alaska, and they are occasionally found in damaging numbers in the principal agricultural sections. At least three species [6] are known to be of economic importance (figs. 13, 14, and 15). All are similar soil-inhabiting forms native to the Territory. In this brief account the species will not be distinguished. Originally they probably infested soils wth grass or native herbaceous cover, but now they more commonly appear in cultivated lands.

The detailed life histories of none of these species have been worked out under Alaskan conditions. They overwinter in the soil, however, probably as larvae or pupae, and emerge as adults in May and June.

Economic injury results when wireworms feed on the roots of such cultivated crops as potatoes and various garden vegetables. In feeding they usually burrow into the roots, bulbs, or tubers of the food plants. They were found injuring cabbage, cauliflower, onions, and various other vegetables at Matanuska, College, and Homer, the attacks often killing small plants. Most of the damage, however, has been done to potatoes. Severe damage to this crop has been observed and reported especially at Fairbanks and Homer, and less severe damage at Matanuska. The damage is due to tunneling into the seed pieces and the newly forming tubers. Seriously injured seed pieces produce weak and nonproductive plants, while injured potatoes are

[6] *Limonius pectoralis* LeC., common at Fairbanks and College; *Ctenicera lobatus* (Esch.), common at Matanuska, Homer, Unalaska, Sitka, and many other coastal localities; and *Ctenicera morulus* (LeC.), common at Matanuska and Fairbanks and also collected at Haines. A fourth species, *Hypolithus bicolor* (Esch.), is of uncertain economic importance. It is common in cultivated and pasture land and has been taken or reported from Kenai Peninsula, Kodiak and adjoining mainland, and Mt. McKinley National Park, and is common in the Matanuska Valley.

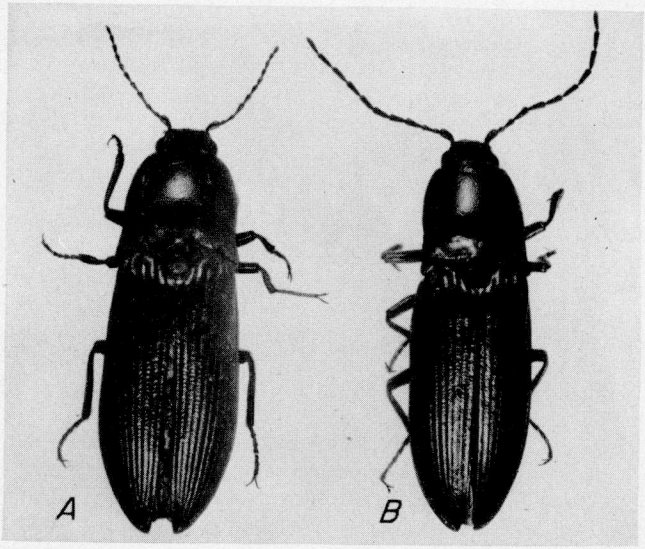

FIGURE 13.—Adults of the wireworm, *Ctenicera morulus* (Lec.): *A*, Female; *B*, male. About four times natural size. (Photographed by J. C. Garman.)

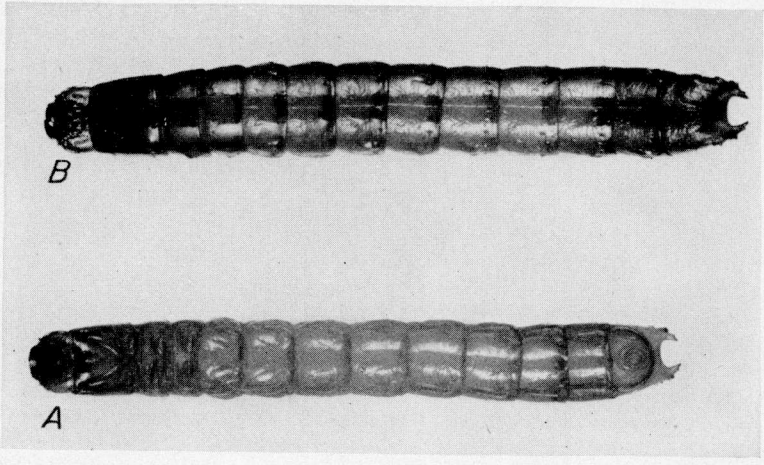

FIGURE 14.—Larvae of the wireworm, *Ctenicera morulus* (Lec.): *A*, Under side; *B*, upper side. About six times natural size. (Photographed by J. C. Garman.)

unattractive and inedible, and must be culled out before potatoes are marketed.

Avoidance of wireworm injury.—Much wireworm injury may be avoided by not planting susceptible crops, particularly potatoes, in land known to be seriously infected. Such information may be ascertained in advance of planting by means of baits made of whole-wheat flour, which is especially attractive to wireworms. Each bait, a compact handful of moistened whole-wheat flour, is placed at random in

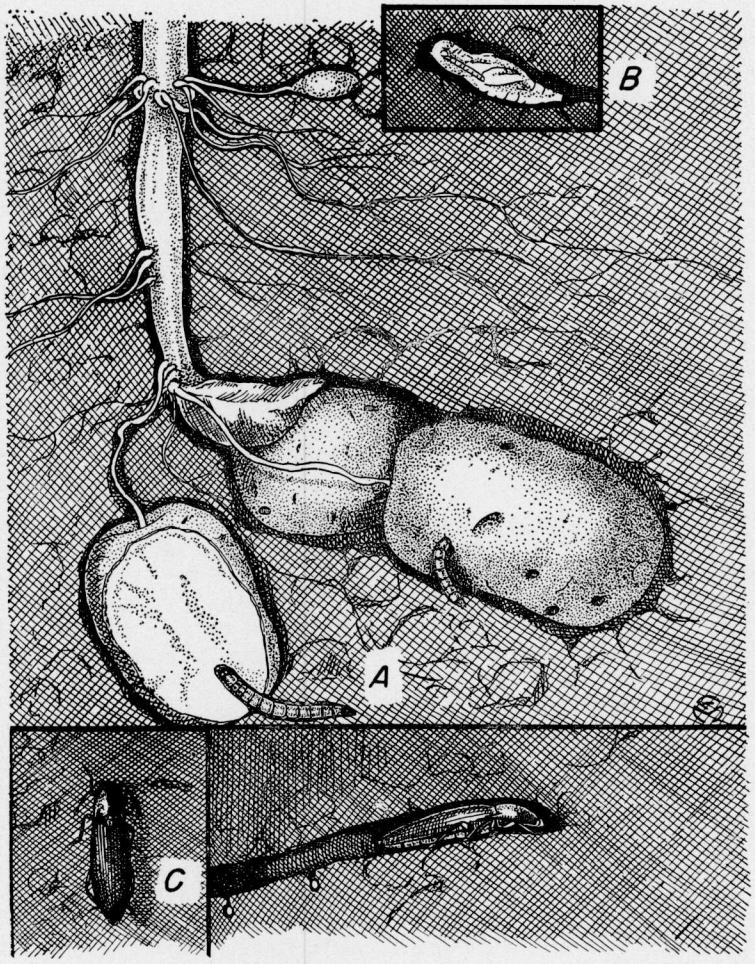

FIGURE 15.—Wireworm injury to potato showing: *A*, Larvae, *B*, pupa, *C*, adults. Slightly reduced.

the field to be sampled. Ten to twenty baits distributed at various points in a small field should give a fair idea of the infestation. The baits are buried individually, 4 to 6 inches deep, each being marked by a stake. Within a day or so they will have absorbed sufficient moisture from the soil to become doughy masses or balls. At the end of the third or fourth day the baits are dug up, broken apart, and the number of wireworms found in the bait and closely adjacent soil are counted. If wireworms average fewer than one or two per bait the damage to be anticipated will be slight. If the average is as high as five or more per bait, however, moderate to severe damage may be expected, and such ground should either be avoided for the planting of susceptible crops or else treated with insecticide to kill the wireworms present.

Suggestions for wireworm control.—Effective methods were un-

known until the past few years for the control of wireworms in cold soils such as characterize Alaska. Recent investigations by M. C. Lane and his co-workers in the U. S. Bureau of Entomology and Plant Quarantine have shown, however, that the fumigant ethylene dibromide is effective at temperatures as low as 34° F. Simple and inexpensive methods for the application of fumigants during plowing have been devised.[7] Current information on rates and time of application should be secured from a qualified entomologist before fumigants are employed for the control of wireworms.

***Caution.*—Prolonged exposure of the skin to ethylene dibromide solution will cause severe irritation and burning. The material is poisonous and its vapors should not be breathed. The solution should not be transferred from one container to another except in open air. It is combustible and should be stored in tightly closed containers in a cool place away from dwellings and open fires.**

LEAF BEETLES, OR CHRYSOMELID BEETLES

The leaf or chrysomelid beetles comprise a family of small to medium-sized beetles, that are of especial importance economically because of their vegetarian habits both as adults and larvae. They include such common and well-known pests as the Colorado potato beetle, the cucumber beetle, and the flea beetles. Chrysomelids are frequently brightly colored with metallic blues and greens. Often both larvae and adults feed upon the foliage of their favored food plants; at other times the larvae live in the soil and feed upon roots and tubers, while the adults feed upon the foliage. Of the known Alaskan species, two may be considered of minor economic importance.

The red turnip beetle.—The red turnip beetle is found in central Alaska, but has not yet been collected at Matanuska, Homer, or other coastal localities. Its distribution ranges from Alaska through Canada into Minnesota and the Rocky Mountain region of the United States. In parts of western Canada it is a serious pest of cole crops, but it has not thus far been of importance in the United States. In Alaska damaging outbreaks have occurred at Circle Hot Springs and Circle City, and minor damage has been occasionally reported in the Tanana Valley. A closely related species is found in Europe, Persia, and southern Siberia, where it is also an important pest of cole crops, especially rape.

The red turnip beetle is about one-fourth inch long, oval, and strongly convex. The ground color is red, but there are black markings on the head and thorax and three longitudinal black stripes on the wing covers, or elytra.

The eggs, which are oval and bright red, are laid in the late summer and fall, in loose masses on small objects on the soil surface or in crevices of the soil near their food plants. Overwintering takes place in the egg stage.

The larvae hatch in the early spring and feed upon weeds or other plants of the mustard family. The food plants are thus the same as those favored by the turnip maggot. When small the larvae are

[7] COOK, WILLIAM C., and LANE, MERTON C. THE APPLICATION OF SOIL FUMIGANTS WITH A PLOW. U. S. Bur. Ent. and Plant Quar. ET–236, 3 pp. 1947. (Processed.)

orange with black spots, but when mature they turn black. The full-grown larva may reach a length of nearly one-half inch.

When full grown, the larvae pupate in the soil at a depth of about 1 inch. Adults start emerging in June and remain active until fall. The adults, like the larvae, feed upon the foliage of mustard and related garden crops. There is only one generation annually.

Both adults and larvae have been successfully controlled in Canada by means of sprays or dusts containing calcium arsenate or paris green. Poison baits, such as are used in cutworm control, are said to be helpful.

The recommended dilution of dusts is 1 part of calcium arsenate to 10 or 12 parts of inert carrier such as slaked lime or talc; or 1 part of paris green to 15 to 20 parts of carrier. A satisfactory formula for sprays is 1 pound of paris green, 4 pounds of hydrated lime, and 50 gallons of water. Spray solutions should be kept agitated during the application to prevent settling.

***Caution.*—Paris green and other arsenical dusts and sprays should not be applied to leafy vegetables such as cabbage, broccoli, and cauliflower after the heads have started to form, because of the danger of poisonous residues. See other precautions on pages 3–4.**

Clean cultivation of gardens and the elimination of weeds, especially wild mustards, early in the spring before susceptible plants are set out is very helpful in reducing damage from this pest and should be practiced in conjunction with spraying or dusting.

The striped flea beetle.—The striped flea beetle is an oval, shining black beetle about one-sixteenth inch long, marked by an irregular longitudinal yellow stripe on each side of the body. A related species, *Phyllotreta zimmermani* Cr., has also been reported. Flea beetles have enlarged hind legs, that enable them to make active flealike jumps.

The striped flea beetle is widely distributed in Europe, Japan, and China, as well as in the United States and Canada. It is a serious pest of cole crops in many places.

In Alaska this species has been found at Rampart and Circle City on the Yukon River, at Circle Hot Springs, in the Tanana and Matanuska Valleys at Copper Center, and at Homer. Damaging populations have been reported from Circle and Rampart, and they were abundant, particularly on turnips and radishes, in the Tanana Valley in 1945. While present and fairly common at Matanuska, they were not seen in damaging numbers during the period of these studies.

When abundant, flea beetles do great damage, feeding upon the leaves and often nearly defoliating plants. Small or newly germinating plants are especially subject to injury and may be killed outright in heavy infestations.

Flea beetles may be controlled by dusts containing 5 percent of DDT or by the same dusts and sprays suggested for the control of the red turnip beetle. Poison baits are not effective.

Western grape rootworm.—The western grape rootworm is a robust convex, light to medium brown, beetle about one-sixth inch long. It is a serious pest of grapes in parts of the western United States.

The larvae, or grubs, feed upon the roots of the host plants. This species occurs in the Matanuska Valley, the Tanana Valley, and many other parts of Alaska, where it is most commonly found on fireweed. It is obviously not a pest in Alaska.

Waterlily beetles.—At least two species of the genus *Donacia* (*hirticollis* Kby. and *dubia* Schaeff. (?)) occur commonly in the Matanuska Valley, and at least five other species are recorded from the Territory. Beetles of this genus are subaquatic in habit, feeding upon the leaves and stems of pond lilies, pickerelweed, and other aquatic plants. The leaves of water lilies at Kings Lake and other lakes in the Matanuska Valley were severely damaged by the larvae of these insects in 1945.

RASPBERRY FRUITWORMS

Raspberry fruitworms *Byturus* spp. (fig. 16) are pests of raspberries throughout much of North America. One species is widely distributed in Alaska, probably wherever raspberries, thimbleberries, or related plants grow. It is the common cause of wormy raspberries. Specimens have been collected from Haines, the Matanuska Valley, Eklutna, the Tanana Valley, Circle City, and Circle Hot Springs. In general, it seemed to be most abundant in the interior sections.

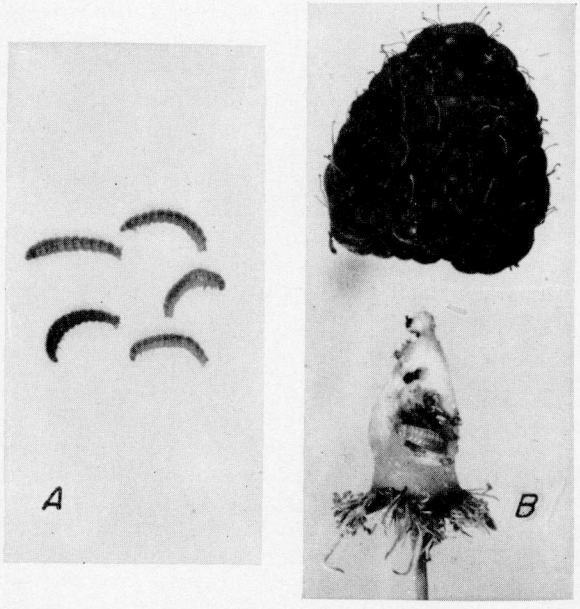

FIGURE 16—Raspberry fruitworm: A, Larvae; B, infested fruit of red raspberry with fleshy receptacle removed to show a larva feeding near the center.

Raspberry fruitworms are the larvae of a narrow-bodied, yellowish-brown beetle about one-sixth inch long. The adults appear in the spring. They feed upon the fruit buds and unfolding leaves, often eating into and destroying the fruit buds. During the blossoming

period the beetles feed upon the stamens, pistils, and other parts of the blossoms. Injured blossoms show discoloration or may be killed and such fruit as matures is often misshapen.

The eggs are deposited on the buds, blossoms, or stems of the raspberry. Upon hatching, the larvae work into the center of the developing fruits, where they feed mostly upon the central core but sometimes upon the fruit itself. Infested berries are often crumbly when picked. The mature larvae drop to the ground and pupate in the soil, from which they emerge as adults the following spring.

Aside from the direct damage done by raspberry fruitworms, their presence in the harvested fruit is objectionable, and they are difficult to remove in cleaning. This is a matter of particular concern where fruits are grown for commercial processing.

Raspberry fruitworms may be controlled by treatment with dusts or sprays containing rotenone to kill the adult beetles before the eggs are laid. Once the worms are present in the fruit, control is impossible. The recommended strength is 0.01 percent of rotenone in sprays or 0.75 percent in dusts. Three applications are generally required. The first application should be made about 5 to 7 days after the first blossoms appear, and two additional applications 10 days apart should follow.

WEEVILS, OR SNOUT BEETLES

True weevils are small to large convex beetles with slender, elongate snout, or trunklike prolongation of the head. The chewing mouth parts are situated at the tip of this snout. Many species of weevils are serious plant and stored-product pests. Of those found in Alaska, only a few are of potential concern to agriculture and their present importance is very minor.

Mustard weevils.—Beetles of the genus *Ceutorhynchus*, here called mustard weevils, consist of many species of insects that feed upon plants of the mustard family. Some are serious pests of cole crops. Those found in Alaska are the cabbage curculio as well as *C. pusio* Mann., *C. americanus* Buch., *C. fulvotertius* Fall., and two other unnamed species.

The cabbage curculio is the only one of these species definitely recorded as a pest. It was not found in the studies reported in this publication, but has been recorded from Nenana in the Tanana Valley. The cabbage curculio is oblong-oval, yellowish gray, and about one-eighth inch long. The eggs are laid in the stems of the host plant, in which the larvae typically feed. The larvae may also feed upon the leaf margins to some extent. When abundant this species may be of considerable economic importance. It is said to have been introduced into the United States from Europe. So far as is known, it is not a pest in Alaska.

Bronze apple tree weevil.—Larvae of a beetle tentatively identified as the bronze apple tree weevil were collected under the bark of a dying apple tree at Haines, Alaska, in August 1945. The species has also been reported previously from Alaska (at Wrangell). The larvae of an unnamed species of long-horned beetle (flathead borer), belonging to the genus *Leptura*, were found in association with the present species infesting the dying apple tree noted above. Whether

either species was primarily responsible for the dying condition of the tree is unknown.

The adult of the bronze apple tree weevil is one-sixth to one-fourth inch long and metallic, bronzy black. Overwintering occurs in the adult stage. The eggs are laid in spring in punctures of injured or dead bark. The larvae mine under the bark and into the wood of injured, dying, or dead trees, or in wounds or dead areas of healthy trees. Alder is a common native host of the bronze apple tree weevil, but the weevil sometimes infests and injures apple, as well as cherry or prune, trees.

The suggested control is to destroy dead prunings and to protect injuries and pruning scars by careful waxing or painting.

Moths and Butterflies (Lepidoptera)

Moths and butterflies are insects familiar to everyone. They include many of the most beautiful and interesting insects known, as well as some of the most destructive. Many species, aside from the cutworms, which have already been discussed, are found in Alaska, but only a few of them are of agricultural significance, most of them finding their food plants in wild vegetation.

SOD WEBWORMS

One or more species of sod webworms (*Crambus* spp.) are common in the Matanuska Valley and other parts of Alaska, but their economic status is not yet known. Where abundant, sod webworms may be very destructive in pastures, grass plantings, and sometimes in grain fields.

Adult sod webworms are usually pale brownish moths about one-half to five-eighths inch long. When at rest, the wings fold closely against the abdomen, and there is a pronounced projection from the front of the head, suggesting one of their common names—snout moths. They are common in grassy areas during June and July at Matanuska. When flushed from their hiding places in the grass, they make short zigzag flights ahead of the disturbance. The larvae, which inhabit loosely woven silken tunnels in the ground at the base of infested grasses, are thick-bodied, usually spotted, and somewhat bristly caterpillars or worms about three-eighths to one-half inch long when full grown. Larvae feed actively in late spring and early summer, both at the roots and on the foliage of infested plants.

Effective insecticidal treatments for the control of sod webworms have not, as yet, been developed.

THE SPINACH WEBWORM

A small moth, which may be tentatively termed the spinach webworm, was found to be common during 1943–45 at Matanuska, where it damaged spinach, beets, swiss chard, and lambsquarters.

The adults are brownish moths about one-quarter inch long, and the larvae are slender, brown caterpillars about three-eighths inch long when mature. Larval infestations were noted from late July to early September.

The larvae feed in small colonies, principally on the seed stocks and terminal leaves of the host plant, which they web together with irregular strands of silk to form silken tunnels. There they remain concealed and feed upon the adjacent leaf and stalk tissues. Since their attacks are usually made after the plants have passed the edible stage (July and August), they are not likely to be a troublesome pest, except possibly where plants are being grown for seed.

THE FIREWEED SPHINX MOTH

The insect tentatively referred to as the fireweed sphinx moth or fireweed hornworm is common in the Matanuska Valley and at least as far north as the Yukon River. It attracts attention in both the larval and the adult stages because of its large size and striking appearance, but is of little or no economic importance. However, it could be extremely destructive if it should ever develop a taste for cultivated crops.

The adults are large, heavy-bodied, narrow-winged, brilliantly colored moths, which fly from mid-June to early July, at which time they may frequently be seen in the late evening hovering over blossoms in much the manner of a humming bird. The larvae are large, heavy-bodied caterpillars of variable coloration, ranging from rather pale brownish or green to nearly black with conspicuous, often red spots along the sides. They are especially marked by a distinct, slightly curved, bright red horn on the back near the tail end. They are 2 inches or more in length when fully grown. The favored food seems to be fireweed, upon which they are often very abundant and destructive. They have also been taken occasionally on potatoes and on tomatoes in greenhouses.

CODLING MOTH

The codling moth was reported to have damaged apples at Sitka in 1915 (Alaska Agricultural Experiment Station Annual Report, 1915). The identification of the insect involved, however, is uncertain. Inquiries at Haines elicited the response that the codling moth did not occur in that area and no evidence of its presence was seen in August 1945.

THE APPLE FRUIT MOTH

The apple fruit moth was reported to have injured apples at Sitka in 1915. Determination of the species was based on larval specimens submitted to A. L. Quaintance, of the United States Bureau of Entomology, by C. C. Georgeson, then superintendent of the Alaska Agricultural Experiment Station. The determination was listed as doubtful, but is almost surely correct. The apple fruit moth was found abundantly infesting mountain ash berries at Matanuska in 1943. The species is a pest of some significance in British Columbia but does little or no damage in Alaska under present conditions.

The adult is a small pale yellowish moth, with the forewings a dark purplish brown marked with a darker oblique band along the foremargin. The larvae, or caterpillars, burrow into apples, as well as into the berries of the mountain-ash which seems to be its native host.

True Flies (Diptera)

True flies are very small- to moderate-sized insects, the adults of which have a single pair of wings. The larvae vary greatly in structure, but are typically maggots.

Flies are among the commonest and most diverse of insects. Many, such as the root maggots, are important plant pests. Others, such as the mosquitoes, horseflies, and white sox or blackflies, are bloodsuckers and feed upon man and animals. Still others are scavengers and feed on decaying animal and plant material. Flies are probably the commonest and most abundant insects to be found in Alaska. With the exception of the root maggots and possibly some of the crane flies, none are of present importance as crop pests.

Crane flies [8] are large, mosquitolike flies almost an inch long. They have long, fragile legs, and are sometimes incorrectly called daddy-long-legs. Their larvae are often abundant in sod and pasture lands and are commonly known as leather jackets because of their tough resilient skin. These larvae are cylindrical, legless, and measure one-half to three-fourth inch long. They are gray to grayish brown and closely match the soil in which they occur. They feed largely upon dead and decaying vegetable matter, but some species attack the roots of living plants, particularly grasses, and may be destructive to range and pasture lands.

Crane flies of many kinds, some wingless, are found in Alaska. Because of their relatively large size and obscure coloration, they are sometimes mistaken for cutworms. No definite crop injury resulting from them has been noted.

THE CELERY ROOT FLY

A species of Syrphidae, or flower fly here tentatively termed the "celery root fly," was reared from larvae found sporadically infesting the roots and crowns of occasional celery plants at Matanuska in 1943 and 1945. No general infestation of celery plantings was noted, but the individual plants attacked were completely destroyed.

Adults of this species are moderately large, brightly colored, hairy flies resembling a small bee in general appearance. The larvae are legless, grublike maggots of moderately large size and of a tough, leathery texture. They are somewhat flattened and relatively broad, and measure about three-eighths to one-half inch long when mature. Species of the genus *Chilosia*, to which the celery root fly belongs, are said normally to infest the bark of trees where they feed upon fresh sap. Should the tendency for this species to infest celery persist, the species may develop into a pest of considerable concern.

THE WHEAT STEM MAGGOT

The wheat stem maggot adult is a slender, yellowish-green fly slightly less than one-sixteenth inch long. The eggs are laid on the stems or beneath the sheath of grasses, wheat, and other cereals. The pale, slender, greenish larvae, or maggots, which measure nearly one-

[8] Family Tipulidae. Among the species of crane flies reared from larvae collected in agricultural land at Matanuska are *Pales ferrugineus* (F.), *Tipula angulata* Lw., *T. appendiculata* Lw., *T. arctica* Curtis, and *T. balioptera* Lw.

fourth inch long when mature, mine the stem, kill the central shoot of young plants and weaken older plants, and prevent proper development of the heads, and thus cause what is known as white heads in wheat. The wheat stem maggot is an important pest of wheat in parts of the United States and Canada.

Adults of this species were collected at Matanuska in 1944 and 1945, but no actual infestations of crop plants were noted. It is not known to be a pest under Alaskan conditions and, probably, primarily infests native grasses.

THE SQUASH ROOT MAGGOT

The squash root maggot is the larva of a small fly. It is reported as breeding in mushrooms in Europe, and as infesting and damaging the roots of young squash plants in Colorado. Adults of this species were taken in the Matanuska Valley in June 1944, but no larval infestations were observed. It is probably of no importance in Alaska.

THE SPINACH LEAF MINER

The spinach leaf miner is a slender, gray fly about one-fifth inch long. It is related to the root maggots of the genus *Hylemya*, but differs from them in that the eggs are laid singly or in small groups on the underside of leaves of plants of the beet family, including beets, spinach, chard, and lambsquarters. The maggots feed between the epidermal layers of the leaf, forming serpentine or blotchy mines. When the maggots are abundant, the affected leaves may be completely destroyed. These flies pupate in the soil, and overwinter in the pupal stage. The spinach leaf miner is a pest of some moment under some conditions in both Europe and the United States.

The spinach leaf miner is abundant at Matanuska, but it was observed to infest only lambsquarters, even where spinach, chard, and beets are equally available. It is not now an agricultural pest in Alaska.

SAWFLIES

Sawflies are four-winged insects related to and similar in general appearance to bees and wasps, but differing from them in that the abdomen is broadly joined to the thorax instead of being attached by a threadlike waist, or pedicel. The larvae are almost exclusively vegetarian and are superficially very similar to ordinary caterpillars in appearance. Many species feed upon the foliage of native and cultivated plants; others form galls on the leaves of willows and other plants on which they feed; others infest fruits such as the blueberry; while still others are wood borers and work in the stems and trunks of shrubs and trees. Some are important pests of forest trees.

Many species of sawflies are found in Alaska, most of which are of no present significance to farm crops. The few that appear to be of possible concern are briefly noted.

MEADOW SAWFLIES

Some species of sawflies belonging to *Dolerus* and related genera are found commonly in pastures and forage plantings at Matanuska, and

no doubt elsewhere in Alaska. The larvae feed upon grasses and upon the foliage of clover, alfalfa, and other legumes. Such species may have some importance as pasture pests, but they have not been observed in sufficient abundance to be of great significance.

SAWFLIES INFESTING RASPBERRIES

Certain sawflies[9] feed upon the foliage of wild and cultivated raspberries, and slight to moderate foliage damage to these plants has been noted in the Matanuska and Tanana Valleys and at Circle Hot Springs. It is probable that several species find a favored host in raspberries and that severe damage may result from their attack. Sawfly larvae usually eat irregular scallops into the sides of the leaves. Sometimes, however, the damaged leaves have numerous, narrow, slit-like strips eaten from them in a direction more or less parallel to the veins, probably as a result of larval feeding while the leaves are still incompletely expanded. Sawfly injury to raspberries was especially common in the Tanana Valley and at Circle Hot Springs in 1945.

Sawflies on raspberries may be controlled by the use of rotenone-containing sprays or dusts as recommended for the raspberry fruitworm. Control applications should be made as soon as the larvae appear.

THE BLUEBERRY FRUIT SAWFLY

A small sawfly larva, which may be tentatively called the blueberry fruit sawfly (*Pristophora* sp.) was taken in small numbers infesting ripe blueberry fruits at Haines, Alaska late in August 1945. If present in abundance this insect could be of considerable economic importance should blueberries ever be commercially grown or harvested.

HOUSEHOLD AND STORED-PRODUCT INSECTS

Household insects have not been studied extensively in Alaska, although a number of important species are known to occur. Unlike agricultural pests, household and stored-product pests tend to be much the same under all conditions of geography or climate. Moreover, they are readily and unsuspectingly transported from place to place in baggage, household goods, stores, and commercial shipments. Therefore, very much the same species are found in Alaska as elsewhere, and recommendations for their control are essentially the same.

Among the most effective insecticides to be recommended for the control of many house-infesting insects are sprays and dusts containing DDT. Household sprays containing DDT are usually solutions of about 5 percent strength, in a highly refined kerosene oil (about 6 ounces of DDT per gallon of oil). The dusts should contain 10 percent of DDT.

***Caution.*—All kerosene-base sprays are inflammable, and must be used with caution. Good ventilation should be provided, and all fires or open flames avoided, during the application.**

[9] *Tenthredo xantha* Nort., *Tenthredo ornaticeps* (Cr.), and other species as well. The true raspberry sawfly, *Priophorus rubivorus* Roh., has not yet been identified from Alaskan material.

Oil solutions of DDT should never be applied to animals, and the skin of the operator should be protected from contact with the spray.

The household and stored-product insects that are found in Alaska, together with methods for their control, are discussed in the following paragraphs.

Cockroaches and Silverfish

Native species of cockroaches are not found in Alaska, but the introduced German cockroach (fig. 17), is a well-established pest in many parts of the Territory, particularly in seaport towns and on shipboard. It is the only species of domestic cockroaches known to be established in Alaska. Severe infestations have been observed at Seward, Anchorage, Curry, and Fairbanks.

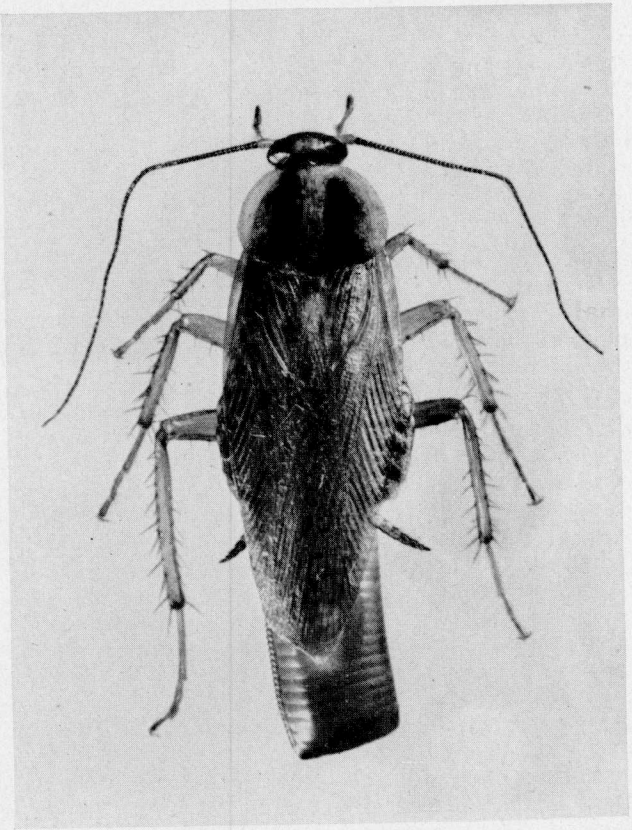

Figure 17.—The German cockroach, with egg capsule protruding. Enlarged.

Cockroaches are especially destructive and annoying in hotels, restaurants, stores, hospitals, and homes. They eat organic matter of all kinds. They often disfigure fabrics, bookbindings, and similar articles, and damage food products. Since they feed freely on gar-

bage and other waste materials, their habit of running over food designed for human consumption makes them potential disease carriers. When abundant, cockroaches have a characteristic nauseating odor.

Adult German cockroaches are much flattened, light-brown insects, with two parallel dark stripes on the thorax. They measure one-half to five-eighths inch in length and, although provided with wings, are specially adapted to running, only rarely taking to flight. They run rapidly, often with a scratchy or scuttling sound, especially when suddenly startled as when a light is switched on in a dark room. They conceal themselves during the day in sheltered, darkened places, such as crevices near sinks, drainboards, or cupboards, and behind baseboards.

Good sanitation, including the protection of both foodstuffs and waste materials in insect-tight containers and the elimination of cracks and similar favored hiding places, will do much toward reducing the numbers of these insects.

Infestations may be controlled by the use of various insecticides. Chlordane, DDT, sodium fluoride, pyrethrum or pyrethrum plus an activator such as one of the piperonyl compounds, are all effective against roaches when applied as sprays or dusts. The material should be applied, forcibly if possible, into crevices along the backs of shelving, drainboards, or other hiding places. One application is sometimes sufficient, and two or three applications, a week to 10 days apart, will usually control an infestation.

***Caution.*—Most roach insecticides are poisonous to man and other animals. Every precaution should be taken to prevent contamination of food products and to keep insecticides out of the reach of children or pets.**

Two species of silverfish are found in Alaska, the common silverfish (*Lepisma sp.* (probably *sacchraina* L.)) and the firebrat. (fig. 18.) Serious infestations have been noted at Palmer in the Matanuska Valley and at Fairbanks. Both species are slender, flattened, wingless, scale-covered insects, slightly more than three-eighths inch long. The common silverfish is uniformly dark or silvery gray, while the firebrat is distinctly mottled. Both species have two slender feelers on the head and three slender appendages at the tail end.

Silverfish live in much the same places as do cockroaches. They are often abundant in damp, warm basements, cupboards, and storage boxes, or crevices almost anywhere in the house. The firebrat is fond of very warm places, often harboring around ovens in bakeries, hot bricks and stones lining chimneys, and in and around the conduits for steam or hot-water pipes.

Silverfish cause annoyance and much damage in homes, laundries, bakeries, restaurants, offices, museums, and libraries. They feed upon starchy materials of all kinds, including wall sizing and the paste under wallpaper, which may be damaged and loosened in consequence. They also feed upon the starch in starched clothing, book bindings, and starch-sized papers and documents.

These pests may be effectively controlled with DDT or chlordane dusts or sprays. The insecticide should be directed into crevices and

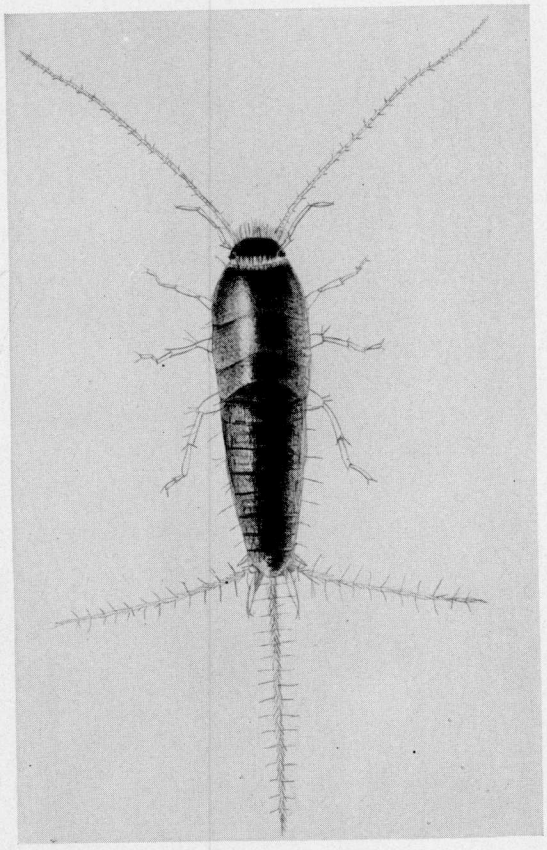

FIGURE 18.—Silverfish. Much enlarged.

other hiding places and over walls, cupboards, and other surfaces where the insects run. The residue left on such objects may be effective for a month or more.

Insects Infesting Flour, Grain, Seeds, and Other Foods

A large number of insects, mostly beetles and moths, feed on stored products, such as grain and flour, and on dried foods, such as beans, peas, fruits, meats, spices, and cheese. The damage is usually done by the larvae. Badly infested foods not only are unfit for human consumption, but serve as sources for subsequent infestations.

There are few records of damage by these insects in Alaska, but the scarcity may be due to failure to report such instances.

Species that primarily infest stored grain, flour, breakfast foods, and other cereal products include the Mediterranean flour moth (fig. 19) a spider beetle (*Ptinus ocellus* Brown), the saw-toothed grain beetle, (fig. 20), the red flour beetle, the cadelle, the rice weevil and the yellow mealworm. The first three of these species seem to be the most common in Alaska.

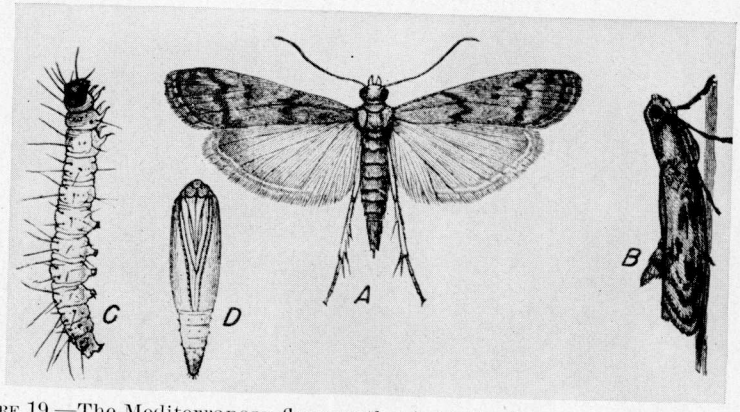

FIGURE 19.—The Mediterranean flour moth: *A*, Moth; *B*, same from side, resting; *C*, larva; *D*, pupa. Enlarged.

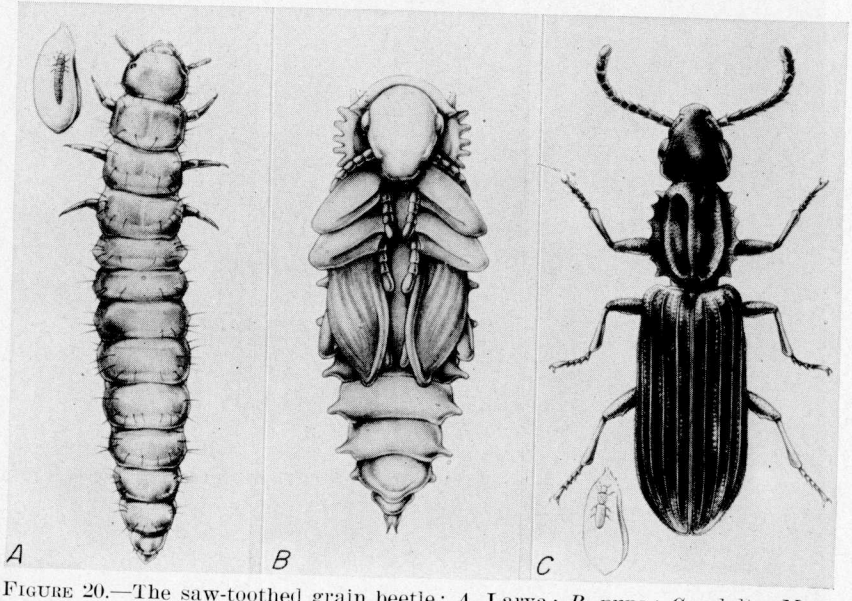

FIGURE 20.—The saw-toothed grain beetle; *A*, Larva; *B*, pupa; *C*, adult. Much enlarged.

The Mediterranean flour moth (fig. 19) is a gray moth about half an inch long with a wing spread of about 1 inch. The wings fold close against the abdomen when the moth is at rest and are marked by wavy black lines. The larvae are whitish or pinkish caterpillars about half an inch long when mature. They spin silken threads wherever they go, webbing and matting the flour particles together.

Spider beetles are reddish-brown, oval, convex, long-legged beetles about one-eighth of an inch long. The larvae form small globular masses or cases of the material in which they feed. Spider beetles are also a menace to furs. They seem to be found more commonly in Alaska than in more southerly regions.

The saw-toothed grain beetle (fig. 20) is a slender, flat insect about one-tenth of an inch long, pale to dark brown, with sawlike projections on each side of the thorax. It infests and damages flour and other cereal products.

The red flour beetle is an oval, somewhat flattened beetle about one-eighth of an inch long, and pale to dark reddish brown. This is a destructive insect pest of milled cereal products.

The cadelle is a shining black, elongated beetle about one-third of an inch long. It is an important pest of grain and flour.

The rice weevil is a dark reddish-brown beetle about one-eighth inch long, with the head prolonged to form a slender snout. It is a serious pest of stored grain.

The adult of the yellow mealworm is a black, convex beetle about half an inch long. The larva is slender and honey yellow, and looks very much like a wireworm. It infests most seriously products that are damp or spoiling. Mealworms also occasionally infest those that are in excellent condition.

To the householder, the control of flour-infesting insects is primarily a matter of sanitation. If not infested when received, flour may be protected indefinitely by storing it in cans or glass containers with tight lids. If it is infested, insect life can be killed by heating the flour in the oven for half an hour at 140° F.

In warehouses, granaries, elevators, or similar storage places, bins, or storage rooms should be well constructed, without cracks or other places where broken grain or flour may accumulate. Broken bags and packages should be disposed of promptly, and the premises should be kept free of spilled grain or flour waste, in which the insects might breed. Methyl bromide is an effective fumigant for cleaning up infested commercial premises but should not be used in homes or in household stores.

***Caution.*—Fumigation operations should be conducted only by experienced persons, and the manufacturer's directions should be carefully followed.**

In some parts of Alaska opening storage places and exposing them for 2 or 3 days to outdoor temperatures in subzero weather will eliminate or control infestations. Water and steam pipes, radiators, and receptacles containing liquids that will freeze should, of course, first be drained.

Beans and peas in storage are sometimes seriously damaged by small weevils. The bean weevil and the pea weevil are small, chunky, rather long-legged beetles, that are brownish and variously mottled with gray. The bean weevil is smaller than the pea weevil, but otherwise similar in general appearance.

Neither the bean weevil nor the pea weevil is a garden pest in Alaska, but dry peas and beans infested with these insects are sometimes received from outside sources. The pea weevil cannot continue to reproduce on dry seed, and such infestations soon die out without further damage. On the other hand, the bean weevil may continue to reproduce, and the infestation may continue as long as seeds are available. Furthermore, weevil-infested seeds may start new infestations in previously clean stores. Severe infestations by either of these

weevils render the peas or beans unfit for human consumption or for planting.

Both the pea weevil and the bean weevil may be destroyed by heat sterilization or by exposure to extreme cold. Where small quantities of beans or peas are involved, heating them to a temperature of 135° F. for 3 or 4 hours will kill all weevils present without preventing germination of the seed. Exposure of infested seed to subzero temperature for several days will also kill all insects present. In this process seeds should be protected from moisture, and they should be completely dry before they are replaced in normal storage. Where large lots of seeds are infested, fumigation with methyl bromide is recommended.

The drug-store beetle (see p. 4) has been recorded from Alaska, but no extensive damage by this pest is known. It is an oval, reddish-brown beetle about one-tenth of an inch long, which infests nearly any plant product, including tobacco, black and red pepper, chocolate and dried roots and leaves such as those used as drugs. Good sanitation, including the prompt disposal of infested products and the protection of noninfested products by storage in insect-tight containers, should largely eliminate this pest.

Insect Pests of Furs, Woolens, Rugs, and Upholstery

Insects that damage furs, woolen goods, rugs, and upholstered furniture in Alaska include the webbing clothes moth (fig. 21), a spider

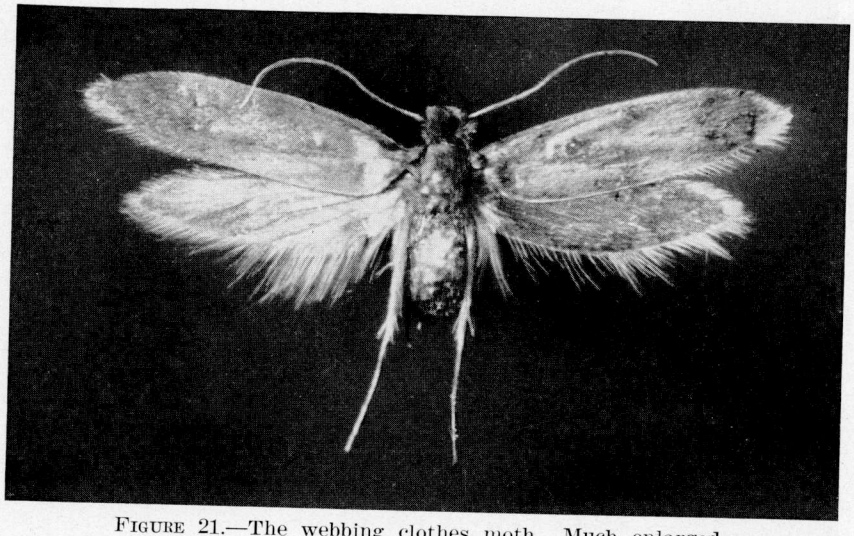

Figure 21.—The webbing clothes moth. Much enlarged.

beetle (*Ptinus ocellus* Brown), the hide beetle, the larger cabinet beetle, and the drug-store beetle. Carpet beetles and the casemaking clothes moth have not yet been reported from Alaska, but will likely be found, occasionally at least. The damage by all these insects is done by the larvae.

Damage from this group of insects in Alaska has resulted mostly from infestations of clothes moths. Spider beetles, in addition to infesting grain products, as previously noted, have been reported as seriously injuring furs.

The webbing clothes moth (fig. 21) is about a quarter of an inch long, with a wingspread of about one-half inch, and uniformly yellowish or buff. The moths frequent dark corners and avoid bright light. The larvae, or caterpillars, are white with dark heads and are about one-half inch long when mature. They spin protective silken tubes in the material in which they feed.

Clothes moths and other insects having similar habits and food preferences find most favorable conditions for development in woolen goods, furs, and similar articles held in storage or used infrequently. Proper storage is therefore essential in avoiding damage. Tight wooden boxes, chests and trunks, sealed cardboard cartons, or sealed and unbroken paper garment bags are reasonably safe, provided the materials in them are not already infested when placed in storage. As an added precaution the stored materials should be sprinkled with naphthalene or paradichlorobenzene flakes prior to sealing the storage container. Dry cleaning or washing in strong neutral soap solution will kill any insects present but will not protect against reinfestation.

Storage closets may be kept free from moths and other fabric-infesting insects, if there are no cracks in the walls, baseboards, or floor, and the doors fit tightly against a felt or rubber gasket at all joints. Paradichlorobenzene or naphthalene flakes in cloth bags from which the fumes may escape should be hung near the top of the closet. One pound of the flakes should be used for each 100 cubic feet of space. The door should be kept closed at all times except when access is necessary.

Frequent and thorough brushing of clothing, with particular attention to the seams and pockets, will minimize damage from moths. Occasional sunning on the clothesline is also helpful, since moths avoid bright sunlight and the larvae drop from infested fabrics in bright sunshine. If sunning is to be most effective, wrinkles and folds should be straightened out. Frequent and thorough vacuum cleaning will do much to prevent damage to rugs and upholstered furniture.

In most parts of Alaska, where cold weather may be counted on during certain seasons, one of the best ways to eliminate infestations is to place infested articles, whether clothing, furniture, or rugs, on a porch where they will be subject to zero or subzero temperatures for 2 or 3 days. This treatment will kill all insects present, but will not, of course, prevent reinfestation once the articles are returned to infested premises.

Commercial cold storage or fumigated storage also provides excellent protection from moth damage. In commercial or warehouse storage, periodic fumigation with standard fumigants, such as methyl bromide, is recommended. The manufacturer's directions should always be followed carefully.

Various mothproofiing solutions are available that will greatly reduce damage, if they are used according to the directions on the container. Thorough application is necessary to obtain satisfactory protection. Many woolen goods, including rugs and upholstered

furniture, are now mothproofed in the course of manufacture, and certain cleaning establishments also render efficient mothproofiing services.

In combating infestations of clothes moths and similar insects, it is important to remember that these insects feed upon almost any animal substance, including hair, feathers, lint from woolen blankets or clothing, and discarded woolen rags. Neglected places in which these materials accumulate, such as unused closets, drawers, cracks in the floor, or crevices around baseboards, are often breeding places for these insects. As in most insect problems, scrupulous cleanliness is a great help in controlling or avoiding dangerous infestations.

Bedbugs and Fleas

Information from various residents of the Territory make it certain that bedbugs may be found in Alaska, although they were not observed by the writer and there seem to be no published records on their occurrence there.

Bedbugs are flat, wingless, sucking insects, which hide in crevices of beds, upholstered furniture, walls, baseboards, and similar places during the day, but come out at night and suck the blood of sleeping persons or animals. Some individuals show practically no discomfort from their bites, but others suffer irritation. Bedbugs have an offensive odor. They are not known to transmit disease.

Bedbugs may be controlled by the use of a DDT spray. Application should be thorough and directed especially into cracks or crevices in which the insects hide. Spray all infested upholstered furniture and beds and wall surfaces near infested articles.

Fleas have not been definitely reported as pests in Alaska, so far as is known, but it is highly probable that the dog flea is present, especially where cats and dogs are kept as house pets.

Fleas are tiny wingless insects, mostly less than one-tenth of an inch long, greatly compressed at the sides, and provided with powerful hind legs by means of which they leap with great agility. The larvae are wormlike in form and live in the organic debris that accumulates in the bedding of their host, and in floor crevices, rugs, and other places frequented by their host. Adult fleas feed upon blood from their host with their piercing and sucking mouth parts. Fleas are extremely annoying and often painful pests, not only to their usual host but to man as well.

Flea control consists in destroying these parasites on the animal hosts and treating the infested premises to prevent reinfestation. DDT sprays are effective in ridding household premises of fleas. For barns and outbuildings a dust containing 10 percent of DDT or a 2.5 percent DDT spray prepared from 50 percent DDT wettable powder may be employed in place of the more expensive highly refined fly sprays used in homes.

For flea control within houses the recommended rate of application for a 5 percent DDT oil solution is about 1 gallon per 4000 square feet. Applications should be heavier in basements or outbuildings. The spray should be applied to all floors, rugs, and other places frequented by the animals. At the same time dogs should be treated with a dust

containing 10 percent of DDT or 0.5 to 1 percent of rotenone applied thoroughly in the hair along the back from head to tail. For a medium-sized dog about 1 tablespoonful is sufficient. Powders containing DDT should not be used on cats, because their habit of licking themselves may lead to the ingestion of sufficient DDT to cause illness or even death. Flea powders containing rotenone are effective and safe on cats.

***Caution.*—Solutions of DDT in oil should never be used on animals.**

Flies and Mosquitoes

Flies and mosquitoes of many kinds frequently enter houses, barns, and other structures, where they are a great annoyance to both man and animals. Among the common forms found in houses are the various blowflies, bluebottle flies, and greenbottle flies belonging to the genera *Calliphora* and *Lucilia;* the little house fly, the true house fly, which occurs rarely in some localities; vinegar or pomace flies of the genus *Drosophila;* many species of mosquitoes belonging to the genera *Aedes* and *Culiseta*, and a scattering of a single species of *Anopheles* (potentially a carrier of malaria).

White sox or black flies (Simuliidae), no-see-ums or biting midges (Culicoides), and horseflies or moose flies (Tabanidae) do not commonly enter houses, but may sometimes be a nuisance, especially on porches.

Screening will exclude most insects from houses and other structures. Insects that gain entrance in spite of screening may be kept to unimportant numbers by the use of DDT fly sprays or aerosol bombs containing pyrethrum and DDT.

If walls, draperies, ceilings, and screens are carefully sprayed with DDT, the residual effect will control any flies or other insects walking over such surfaces for 6 to 8 weeks or longer. One or two such treatments should keep houses relatively free of such insects for an entire season in Alaska.

Aerosol bombs will rapidly clear enclosed premises of infestations of flies and mosquitoes. The manufacturer's directions should be carefully followed. Aerosol-bomb discharges leave no effective residues; therefore, their use must be repeated.

An effective spray for controlling flies and mosquitoes in barns and outbuildings may be prepared by mixing 2 pounds of 50-percent DDT wettable powder with 5 gallons of water. Substitute methoxychlor for DDT in sprays for dairy barns. To prevent settling these sprays should be kept well stirred during use. Treated surfaces should be wet, but not dripping. The sprays may be applied with either hand or power equipment.

Insects Injurious to Logs, Structural Timbers, and Other Wooden Objects

Insects cause great damage to wooden objects and construction of all sorts. Rustic and log structures, especially if the bark is left in place, are particularly subject to injury. The insects causing these

attacks in Alaska include many kinds of beetles, carpenter ants, and wood-boring sawflies. The damage is done primarily by the larval stages of the insects. At least 30 species of bark beetles (Scolytidae), between 30 and 40 species of roundheaded borers or long-horned beetles (Cerambycidae), 15 or more kinds of flatheaded borers (Buprestidae), at least a few death-watch beetles (Anobiidae), the common large carpenter ant, and a few species of wood-boring sawflies or horntail wasps (Siricidae) may damage wood and wooden structures under certain conditions.

Bark beetles are cylindrical, reddish-brown to black beetles from one-sixteenth to one-fourth inch long. They bore through the outer bark to the cambium layer, where they bore small tunnels along the sides of which the eggs are deposited. Upon hatching, the whitish larvae feed in the cambium, forming side tunnels, often at right angles to the original boring. Their attack loosens the bark and causes it to fall off. Although the wood itself is not greatly damaged directly by the boring of bark beetles, the openings facilitate the entrance of moisture and destructive fungi.

The roundheaded borers are the larvae of robust convex beetles having unusually long antennae—hence the common name "long-horned beetles." They range in length from less than one-fourth inch to more than 1 inch. The flatheaded borers are the larvae of oval or boat-shaped convex beetles. They range from one-fourth inch to nearly 1 inch long and usually have a metallic appearance. Some species of flatheaded and roundheaded borers work mostly in the cambium layers or sapwood, but others form large, oval mines which extend deep into the sapwood and heartwood, greatly weakening the timbers and facilitating the entrance of fungi and other rot-causing organisms.

The death-watch beetles are small, cylindrical-shaped insects. The larvae mine and often destroy dry and seasoned woods and wooden articles of many kinds. Only a few Alaskan species are known. One species, *Hadrobregmus destructor* Fisher, has been reported as seriously damaging wooden articles in the Sheldon Jackson Museum at Sitka.

Wood-boring wasps, or horntails, are large insects, the females of which are provided with long, slender ovipositors. The larvae are wood-boring in habit and are often destructive to forest trees and structural timbers.

The carpenter ants are large black ants, nearly one-half inch long, which often live in large colonies in decaying logs and stumps, and sometimes infest the foundation timbers of houses and other structures.

The protection of log houses and other wooden structures from insect damage comprises two principal phases—prevention of infestation and control of infestations already present.

Preventive measures include: (1) Cutting the trees at the proper season to avoid beetle infestations of the green timber—generally in late fall and early winter after insect activity has ended for the season; (2) storing logs and cut timber off the ground or under shelter to facilitate rapid drying and seasoning before beetles start flying the following season; (3) using proper foundations to keep sills and

other foundation timbers dry and well ventilated, thus avoiding high moisture conditions that facilitate the work of many destructive insects and fungi; (4) peeling the bark where possible to eliminate bark beetle injury and accompanying decay; and (5) treating logs and other structural timbers with preservatives, such as pyridine, creosote, zinc chloride, or pentachlorophenol, which retard or prevent the development of insect infestations.

***Caution.*—These 4 materials are poisonous and pyridine and creosote are highly inflammable. Persons unfamiliar with such operations should secure expert advice or supervision before attempting treatments.**

Infestations in structures already in place or in wooden objects kept in homes, offices, and museums may be controlled in some measure by the application of crude orthodichlorobenzene or paradichlorobenzene dissolved in three times its weight of kerosene. These materials may be applied by dipping the infested objects in the solutions or by painting the surfaces freely with the solutions to permit penetration of the insecticide into the wood. Such treatment may damage or destroy the finish of furniture and other manufactured articles; however, unless controlled these insects will eventually destroy the furniture and articles themselves.

***Caution.*—See precautions on pages 3–4.**

Carpenter ants may be readily controlled by applying dusts or sprays containing chlordane, DDT or rotenone to the galleries and other places frequented by the insects.

Other Department Publications on Household and Stored-Product Insects

For further information on household and stored-product insects and their control, see the following publications of the United States Department of Agriculture:

Leaflet 145. Clothes Moths.
Leaflet 149. Silverfish.
Leaflet 150. Carpet Beetles.
Leaflet 152. How to Control Fleas.
Farmers' Bulletin 1260. Stored-Grain Pests
Farmers' Bulletin 1275. Weevils in Beans and Peas.
Farmers' Bulletin 1655. The Control of Moths in Upholstered Furniture.
Circular 720. Controlling Insects in Flour Mills.
Unnumbered. DDT for Control of Household Pests.

These publications are for sale by the Superintendent of Documents, Washington 25, D. C.

For the following processed publications, write to the Bureau of Entomology and Plant Quarantine, Washington 25, D. C.:

E–681. The Use of DDT for Roach Control.
E–701. The Use of DDT for Bedbug Control.

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