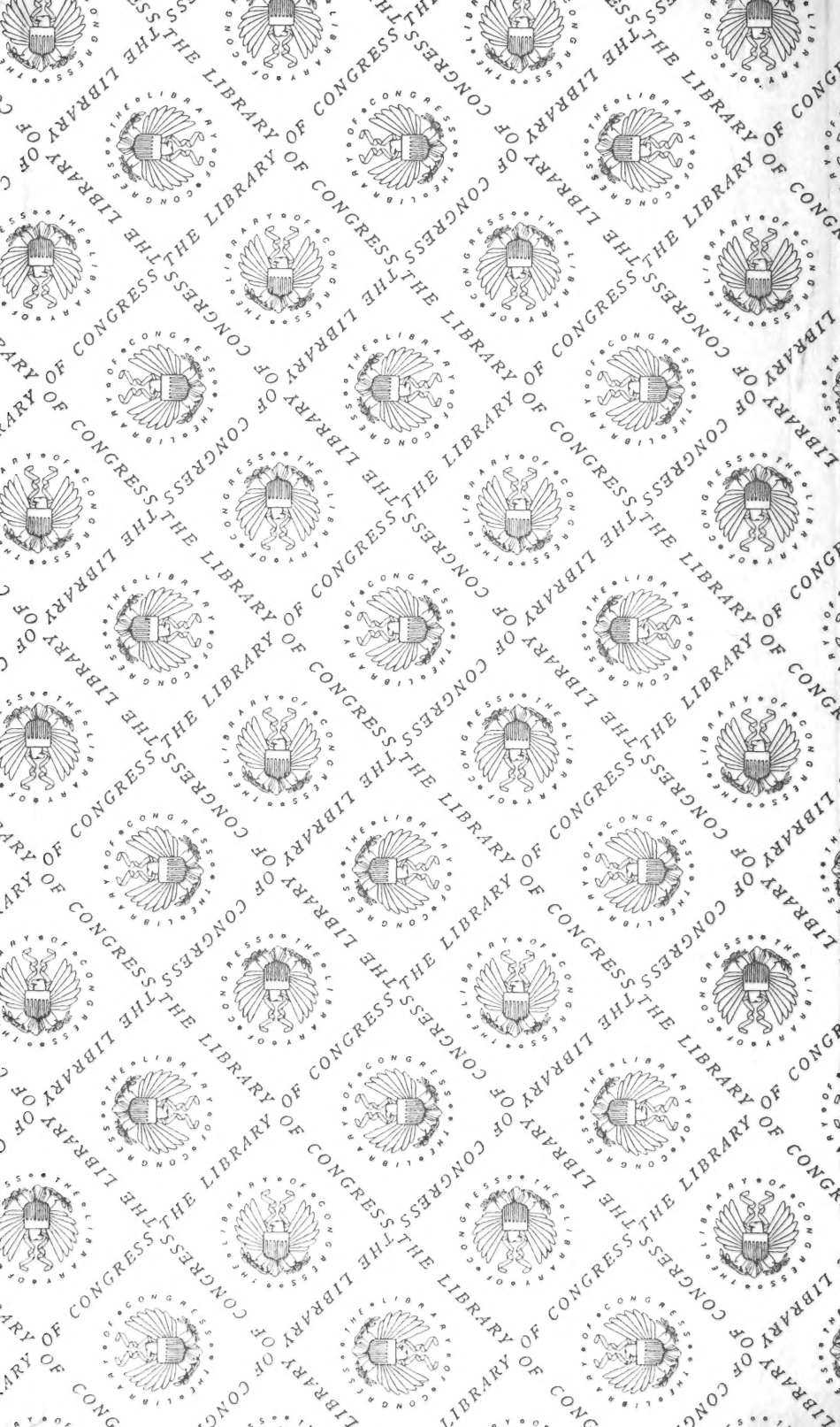
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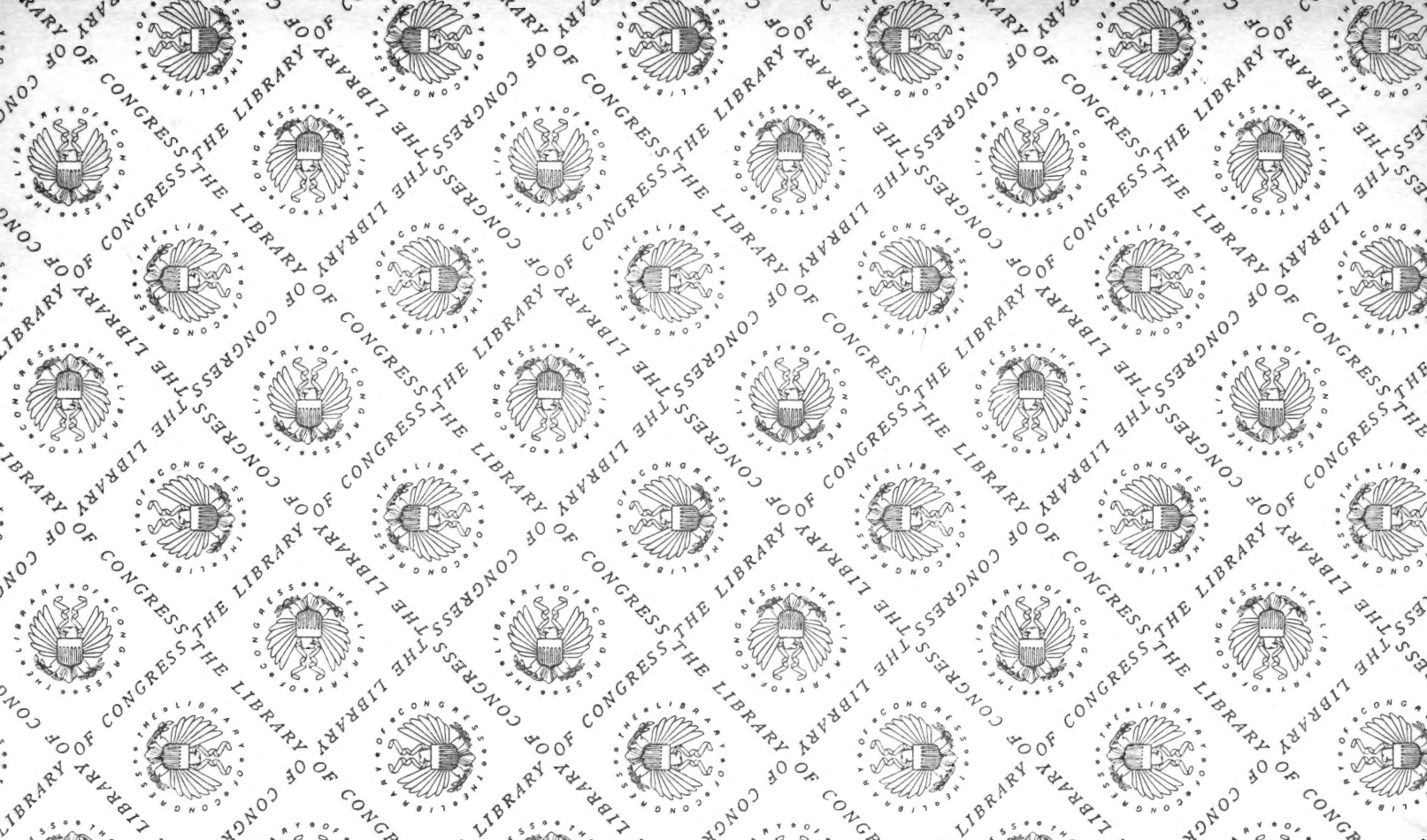
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University of Maine.

Maine Agricultural Experiment Station

ORONO

CHAS. D. WOODS, Director

APPLE TREE INSECTS OF MAINE

by

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and

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MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
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APPLE TREE INSECTS OF MAINE.

EDITH M. PATCH,

O. A. JOHANNSEN.

Before it is possible to combat an insect pest intelligently we must learn something of its habits and of its vulnerable points. When these are known proper remedial measures may then be taken for its extermination or repression. To meet the needs of those who wish to learn something of the commoner injurious insects which affect the apple tree and its fruit this circular has been prepared. It is a compilation largely from the Entomological bulletins and circulars of the Maine Agricultural Experiment Station. We desire to acknowledge the use also of publications of the United States Department of Agriculture and of other sources.

There are very many different species of insects ranging in size from less than 1-50 of an inch to about 8 inches in length. From the United States alone over 30,000 species have been recorded of which over 400 are known to affect in greater or less degree the apple tree or its fruit. Though there are many that are, it must not be supposed that all insects are injurious for by far the larger number are either harmless or actually beneficial. Ruthless destruction of insects by means of trap lanterns and the like is to be deprecated since these methods

are as apt to capture the beneficial and the harmless as the injurious. Poisons, traps, and other repressive measures must be used with caution, and at the right time and place in order to be most effective.

Though technical terms will be avoided in this circular when possible, it may not be out of place here to explain the few which it will be necessary to use in the descriptive matter which is to follow.

Though differing in many particulars all insects possess a segmented body which in the adult stage is arranged in three regions, head, thorax or midbody, and abdomen or hind body. The thorax in the adult is provided with 3 pairs of legs and may be either winged or wingless.

Some insects (e. g., grasshoppers) after emerging from the egg gradually increase in size until they reach maturity but without undergoing any abrupt change in external appearance except in the acquisition of wings. Others, however, pass through 4 distinct stages, viz., egg, larva (caterpillar, or grub or maggot), chrysalis or pupa (often enclosed in a cocoon) and the imago or mature insect. After the insect has acquired wings it is mature and no longer increases in size. Thus a small beetle is not the young of a larger one, nor is a small fly the early stage of one of greater magnitude.

Insects are divided into a number of natural groups or orders by which they are known in technical literature and not infrequently in popular accounts also. The *Orthoptera* are four winged; the first pair are thickened and partly overlap when at rest; the second pair are thinner and are folded in plaits like a fan. The mouth parts are formed for biting. To this order belong the cockroaches, crickets and grasshoppers. The *Neuropteroids* include the dragon flies (popularly known as darning needles), May flies, stone flies and the like. The only insects which are rightly called "bugs" are the *Hemiptera*, creatures of various shapes, having jointed beaks adapted for piercing and sucking. Plant lice (figs. 31, 32), scale insects (figs. 3, 4), bed bugs, plant bugs (fig. 28), etc., belong to this order. The butterflies and moths, scaly winged insects, are classed as *Lepidoptera*. These are harmless to vegetation in the adult stage, but many species in the larval (caterpillar) stage, then provided with biting mouth parts, are among our most destruc-

tive pests. The codling (fig. 40), gypsy, brown-tail and other moths are well known examples. The *Diptera* to which the mosquito, apple maggot (fig. 24), and house or typhoid fly belong, are two-winged when mature. The larva of the mosquito, so common in a rain water barrel, is known as a wriggler, while the corresponding form of the fly is known as a maggot. The plum curculio (figs. 25-27), the apple tree borer (figs. 1, 2), the blundering June beetle, and the potato beetle are members of the *Coleoptera,* insects having hard, shell-like fore wings which meet in a longitudinal line along the middle of the back. Both the larvæ (known as grubs) and the adults have biting mouth parts and in some species are equally concerned in the destruction of plants. Some lady beetles on the other hand are beneficial because they feed on small injurious insects such as scales and aphids. Ants, bees, wasps, a host of species of minute 4-winged parasitic flies, as well as some injurious sawflies are members of the order *Hymenoptera,* the adults of which are four winged. The larvæ, most of which are known as grubs or maggots, usually have well developed heads with biting mouth parts and frequently provided with legs.

While the foregoing classification is adopted in most text books, it is more convenient in dealing with the species of the apple to arrange them in accordance with the character of the injury they cause and to this end we will first divide them into 3 primary groups.

A. Injuring root, trunk or branch; borers and sap feeders. Page 3.

AA. Injuring the foliage; biting or sucking insects. Page 13.

AAA. Injuring the fruit; maggots, caterpillars, bugs and beetles. Page 46.

A. INJURING ROOT, TRUNK, OR BRANCH.

a. *Borers in the wood.*

1. A large white grub about 1 inch long when grown, with brown head; thorax not much thicker than the abdomen. Bores mainly at the base of the trunk. Its presence is indicated by the wood dust it throws out of its burrow. (fig. 1). *Round-headed borers.* Page 4.

2. A whitish grub about ½ inch long when grown, with flattened thorax about twice as wide as the abdomen. Works on the trunk and large branches. (fig. 2). *Flat-headed borers.* Page 7

3. A very small larva which lives in small rounded "shot holes" about 1-16 inch in diameter. Adults are small brown beetles. *Shot-borer beetle.* Page 8.

b. *Scale insects and plant lice.*

1. Scale about 1-10 inch long on twigs; shaped like oyster shell. (fig. 3). *Oyster-shell scale.* Page 9.
2. A small rounded scale. (fig. 4). *San Jose scale.* Page 10.
3. Plant lice with white downy secretion; cause wart-like swellings on roots, and also are found on the twigs. (figs 34, 35). *Woolly aphis.* Page 12.

a. BORERS IN THE WOOD.

1. Round-Headed Apple-Tree Borer.

(*Saperda candida* Fab.)

Fig. 1; a, larva; b, pupa; c, adult. (After Riley).

The first intimation that the grower may have of the presence of this borer in his trees, unless he be forewarned, is in their retarded growth and the sawdust-like castings, consisting of excrementitious matter and gnawings of woody fiber, which the larvæ extrude from the openings into their burrows. This manifestation is usually accompanied by more or less evident discoloration of the bark and, in early spring particularly, by slight exudation of sap.

The parent of this borer is a beautiful beetle, measuring from three-fourths to nearly an inch in length, the male being perceptibly narrower than the female. The legs are gray, the under surface of the body and the head are silvery white, and the upper surface is light yellowish brown with two longitudinal white stripes extending through the thorax and elytra or wing-covers to the tip, as is shown in the accompanying figure 1, *c*.

The larva, when mature, measures from three-fourths to a little over an inch in length. It is legless, fleshy, and somewhat grub-like in appearance, cylindrical in form, and light yellow in color. The head is darker.

The pupa, illustrated at *b*, is nearly as long as the adult insect, which it resembles in a superficial manner, the head being bent down toward the breast, and the legs and long antennæ folded upon the ventral surface. Its color is similar to that of the larva.

The beetles make their first appearance of the season late in May or in June, according to locality. During the night they come forth from the trunks of the trees in which they have bred, and at this time may be seen in flight.

Soon after their first appearance the sexes mate and eggs are deposited. The female first makes an incision in the bark—probably by means of her mandibles—causing it to split slightly; then, turning head upward, she places an egg under the bark nearly a quarter of an inch from the incision, accompanying the deposition by the extrusion of "a gummy fluid which covers and secures it to its place and usually fills up the aperture. In young trees with tender bark the egg is usually thoroughly hidden, while in older trees it is sometimes so shallowly imbedded as to be readily seen."

The larvæ, soon after hatching, tunnel under the bark and feed on the sap-wood, gradually working their way upward and afterwards downward, usually remaining within a short distance of, or below the surface of, the ground, particularly in young trees. By the end of the second year the larvæ have increased considerably in size and have now penetrated deeper into the solid heart-wood, their burrows being closely packed behind them with castings. The third year the larvæ gnaw outward to the bark, form a pupal cell composed partly of their castings and, with their heads pointing toward the bark, transform to pupæ. With the approach of May and June they cut their way out by means of their powerful manibles and issue through a round hole as mature beetles.

METHODS OF CONTROL.

After borers have once entered a tree there is no better remedy known than to cut them out with a knife or other sharp instrument. Cutting the borers out, unless practiced with the

greatest care, is apt to result in injury, and it is far better to prevent the parent insects from depositing their eggs upon the tree. This is not difficult of accomplishment, as oviposition is practically confined to two months in any single locality, usually June and July. The best preventives are impenetrable substances placed about the trunk and various washes of a repellent nature.

For this a few thicknesses of newspaper wrapped rather loosely about the trunk and extending about two feet from the base are all that is necessary. This covering should be tied, by preference with cord, which will readily yield or break with the natural expansion of the tree in its growth, and also be tightly fastened at top and bottom and hilled up with earth so that the beetles cannot obtain access to the tree from below. From the top of this covering upward it is best to use some deterrent alkaline or carbolated wash.

Any one of several washes in general use against boring insects may be used as a deterrent. A good alkaline wash is prepared of soft soap reduced to the consistency of thick paint by the addition of caustic potash or washing soda in solution. A good fish-oil, or whale-oil soap, or common soft soap, is often used, and in some cases any one of these is sufficient to deter the insects from depositing their eggs. The alkaline wash may be carbolated, if desired, by the addition of crude carbolic acid, at the rate of 1 pint to every 10 gallons of the wash. Such a wash not only affords protection against this and other borers, but against scale and fungous diseases at these points, and is, moreover, of positive benefit to the tree. Caustic potash fish-oil soaps are among the best for insecticides.

2. Flat-Headed Apple-Tree Borer.

(*Chrysobothris femorata* Fab.)

Fig. 2; a, larva; b, pupa; c, adult. (After Riley).

The adult insect (represented at *c*, fig. 2), measures from a little less to a little more than a half inch in length. It is flattened above, the upper surface of the body is dark metallic brown, and fresh specimens are coated here and there with a powdery gray substance, which is easily rubbed off. The wing-covers are ornamented as shown in the illustration, and underneath, as may be seen when the insect is in flight, the body is a bright metallic greenish blue. The under surface is coppery bronze.

The larva differs greatly from that of the round-headed borer. Its name, flat-headed borer, is derived from the peculiar flat expansion of the second thoracic segment—which is close to the head. In color it is light yellow and in length measures nearly twice that of the mature insect. It habitually rests in a curved position (fig. 2, *a*). The pupa (*b*) shows the form of the future beetle and is of the same yellow color as the larva.

This borer attacks diseased or dying trees by preference, inhabits all parts of a tree from the base of the trunk to the limbs, and is not restricted to fruit trees. In all these respects it differs from the round-headed borer, but agrees with the latter in that it is injurious chiefly to young trees, its injuries being practically confined to newly transplanted nursery stock and to trees which have been weakened through any cause, such as careless pruning, or insufficient nourishment due to poor soil or drought. Infestation may be detected by the discoloration of the bark.

Remedies.

The remedies advised for the round-headed borer are also of value and are generally employed against the present species. It is necessary, however, that deterrent coverings and washes

should be applied farther up the trunk and to as many branches as can be conveniently reached.

Careful cultural methods.—Careful, clean methods of orchard management are essential as a measure of protection, and involve the cutting out of dead, dying, and injured deciduous forest and shade as well as orchard trees known to be chosen as food by this species. Care should be exercised in transplanting, and especially in pruning; and fertilizers should be used in order that the trees may be thrifty and better able to withstand attack. Proper regard for these measures should give practical exemption from injury.

3. Shot-Borer.
(*Xyleborus dispar.*)

The female beetles bore into the wood, making deep channels which in small twigs interfere with the circulation of the sap, and the twigs wither, giving the appearance of blight. The exit holes through the bark are .06 of an inch in diameter and nearly circular, looking like small shot holes. The wood is green, showing that the insect attacks the growing tree. Living wood does not appear to be essential to the life and comfort of this species, for after a period of several weeks we found in a limb that had been in a dry place in a box, young larvæ, full grown pupæ, and perfect beetles.

When the larvæ are full grown they transform to pupæ in the burrows, and finally emerge as small beetles about one-tenth of an inch long and of a dark brown or nearly black color, with the antennæ and legs of a rusty red. The thorax is short, very convex, rounded and roughened. The wing covers are marked by longitudinal rows of punctures. The hind part of the body slopes abruptly. The beetles leave their burrows in June and July and deposit eggs before August.

REMEDIES.

As the beetles work wholly under the bark they cannot be reached by insecticides. The only way is to watch the trees during the latter part of June and July and, if blighted twigs or diseased limbs are noticed, examine the branches for small pin holes; if found, the presence of this or some related species may be suspected. The diseased limb should at once be cut

far enough below the injury to include all the burrows, and burned, to prevent the beetles emerging and attacking new trees. As these beetles live in forest trees, orchards near timber are more liable to become infested.

b. SCALE INSECTS AND PLANT-LICE.

1. Oyster-Shell Scale.

(*Lepidosaphes ulmi.*)

This scale, which resembles an elongate oyster shell in shape (fig. 3, *b*) has long been known in this country, though believed to be a native of Europe. It is widely distributed and is exceedingly abundant in Maine. Besides seriously injuring apple trees, the twigs of which often densely covered by them, they are found on the pear, plum, currant, dogwood, elm, maple and a number of other trees and shrubs.

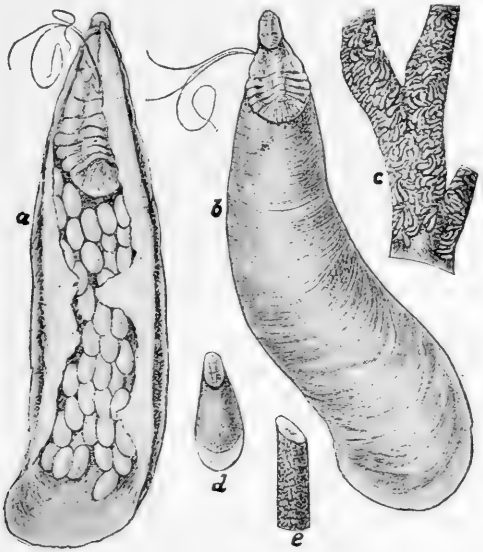

Fig. 3. Oyster-shell Scale. a, female scale from below, showing eggs; b, same from above greatly enlarged; d, male scale enlarged; c, female scales on twig, natural size, e, male scales natural size. (From year book, 1894 U. S. Dept. Agr.)

In June the eggs hatch, the active young appearing as small white specks which soon attach themselves to new shoots by

their beaks. The scale then begins to form, gradually increasing in size. The scale of the female (fig. 3, *a, b, c*) is less than one-eighth of an inch long, narrow, usually curved when not crowded, (fig. 3, *c*) and nearly the same color as the bark upon which it is found. The scale of the male (fig. 3, *d*) is much smaller, less curved and usually not found on fruit trees. As with the San Jose scale the adult male is provided with both wings and legs while the female, remaining under the scale, has neither.

REMEDIES.

This insect is quite resistant to the application of sprays unless it be put on at the time when the young appear, before the formation of the scale. This is about the middle of June, though the exact date cannot be given as it varies with latitude and temperature. As soon as the young larvæ are observed the trees should be sprayed with soap solution (Formula 7), kerosene emulsion (Formula 4), or whale-oil soap solution (Formula 6), repeating if possible a week later. The kerosene emulsion should be put on in sunshiny weather and care should be exercised not to use an excess amount, lest the tree be injured.

2. San José Scale.

(*Aspidotus perniciosus.*)

The San Jose which is one of the worst insect pests of orchards in other states was discovered in the town of Limerick, Maine, in 1909. As there is always a danger of its introduction upon nursery stock from neighboring states, the observation of small circular scales about the diameter of a pin head (fig. 4) upon the twigs of fruit trees should immediately be reported.

Fig. 4. a, Female, scale removed; b, cluster of scales; c, female scale; all greatly enlarged. (After Felt.)

The female scale is circular in outline, grayish or blackish in color, and when examined under a lens will be seen to be somewhat raised above the bark especially in the center where there is a little prominence. When the scale is somewhat rubbed the center portion appears yellowish, around which the concentric circles, representing lines of growth, may be seen (fig. 4, *c*). The full grown male scale is elongated, the prominence near one end and the lines of formation eccentric instead of concentric. If the scale be lifted by means of a needle, there will be seen a little yellowish body; the insect proper (fig. 4, *a*). The newly born insect of both sexes possess eyes, legs, antennæ and mouth parts, and crawl about for a few hours upon twigs. When a suitable place is found they settle, insert their long beaks through the bark and begin to suck the plant juice. The scale begins to form even before the young insect becomes fixed, and is at first pale grayish yellow, gradually becoming darker, the central projection usually remaining lighter colored. The insect under the scale now loses legs and antennæ, the female also losing her eyes. Later the male scale assumes an elongate oval shape, and later still, 3 or 4 weeks after birth, it again undergoes a transformation and appears as a mature insect with legs, antennæ, eyes and wings. The female matures in 5 or 6 weeks, remaining fixed in position under the scale, legless and wingless. There are several generations each season.

REMEDIES.

While there are a number of insect parasites which are natural enemies of the scale, chief reliance must be placed upon fumigation and spraying early in the spring before growth begins to keep it under control. Miscible oils, kerosene emulsions (Formula 4), and lime and sulphur washes (Formula 10) are all to be recommended for sprays, while nursery stock imported from localities known to be infested should be fumigated. Complete directions for spraying and fumigating will be found in Farmers' Bulletin 127, "Important Insecticides: Directions for their Preparation and Use," and "San Jose Scale," Circular 42, Second Series, Division of Entomology. These papers may be obtained upon request by addressing "United States Department of Agriculture, Washington, D. C."

3. Woolly Aphis of the Apple.

(*Schizoneura lanigera* Hausmann.)

Throughout the summer on the lower portion of the trunk and particularly on the water sprouts of the apple may often be seen small bluish-white flocculent or cottony patches, which indicate the presence of colonies of one of the worst enemies of the apple, viz., the insect known as woolly aphis (fig. 34).

It exists in two forms, the one just referred to, above ground on the trunk or water shoots, and another inhabiting the roots. On the roots its attacks induce enlargements or galls or swellings, and in the cracks of these galls and swellings the root form occurs in clustered masses. The injury to the trees is due both to the sucking up and exhaustion of the vital plant juices and to the poisoning of the parts attacked, as indicated by the consequent abnormal growths.

The damage is particularly serious in the case of nursery stock and young trees and is less often important after the tree has once become well established and of some size. Where this insect is abundant all the roots of a young tree to the depth of a foot or so become clubbed and knotted by the growth of hard fibrous enlargements (fig. 35) with the results in a year or two of the dying of the rootlets and their ultimate decomposition with attendant disappearance of the galls and also of the lice, so that after this stage is reached the cause of the injury is often obscure. On the trunks the presence of the lice sometimes results in the roughening of the bark or a granulated condition which is particularly noticeable about the collar and at the forks of branches or on the fresh growth around the scars caused by pruning, which latter is a favorite location. On the water shoots, they collect particularly in the axils of the leaves, often eventually causing them to fall, and on the tender greener side of the stems. The damage above ground, though commonly insignificant, is useful as an indication of the probable existence of the lice on the roots. A badly attacked tree assumes a sickly appearance and does not make satisfactory growth, and the leaves become dull and yellowish, and even if not killed outright it is so weakened that it becomes especially subject to the attacks of borers and other insect enemies.

The common forms both on the roots and above ground are wingless lice, not exceeding one-tenth of an inch in length, and of a reddish-brown color, and abundantly covered, especially in the aerial form, with a flocculent waxy excretion.

In October or November, among the wingless ones, numbers of winged individuals appear, which are also all females, and are the parents of a true sexed generation of minute, wingless lice, the females of which give birth to a single "winter egg." This egg is attached within a crevice of the bark.

The winged females appear somewhat abundantly in autumn, and are one of the means of the dispersal of the insect. They are very minute, clear-winged, gnat-like objects, greenish-brown, almost black in color, with the body covered with more or less of the cottony excretion.

REMEDIES AND PREVENTIVES.

The foregoing account of the habits and characteristics of the woolly aphis will enable us to suggest certain measures to control it. The aerial form presents no especial difficulty, and can be very readily exterminated by the use of any of the washes recommended for plant-lice, such as kerosene emulsion, tobacco decoction, a strong soap wash (Formulas 4, 8, 6), etc., the only care necessary being to see that the wash is put on with sufficient force and thoroughness to penetrate the covering and protecting cottony excretion. If the wash be applied warm, its penetration will be considerably increased.

The much more important root form, however, is more difficult to reach and exterminate. The common recommendations are of applications of strong soap or tobacco washes to the soil about the crown, or soot, ashes, or tobacco dust buried about the roots; also similarly employed are lime and gas-lime."

Badly infested nursery stock should be destroyed, since it would be worth little even with the aphides removed.

AA. INJURING THE FOLIAGE.

(Divisions a, b, c, and d).

a. *Plant lice, small greenish, blackish or reddish lice-like sucking insects.*

1. Greenish plant lice in colonies causing leaf curl. (fig. 33).
Green apple-aphis. Page 16.

2. Reddish plant lice in colonies causing leaf curl.
Rosy aphis. Page 17.

b. *Insects feeding freely upon the leaves without a nest and not concealed within leaf or bud.*

1. A "measuring worm" or looping caterpillar, when grown about 1 inch long; olive green when young, becoming yellowish or brownish when grown; with brownish longitudinal stripes and white band on sides; under side pale or flesh colored. (figs. 5, 6).
   I. With 2 pairs of legs at rear of body. *Spring canker Worm.* Page 18.
   II. With 3 pairs of legs at rear of body. *Fall canker worm.* Page 19.
2. Very large hairless green caterpillar, 4 inches long when grown; body with several red, yellow and blue bead-like tubercles. (fig. 7). *Cecropia caterpillar.* Page 21.
3. A large black and yellow longitudinally striped caterpillar with yellow neck; very sparsely covered with long soft hairs. (fig. 9). *Yellow-necked caterpillar.* Page 22.
4. A caterpillar with black, white and yellow longitudinal stripes; head and fourth body segment bright red, with a number of stiff, blunt black spines. (fig. 10). *Red-humped Caterpillar.* Page 23.
5. A smooth mottled caterpillar; grayish brown above, gray-green beneath with yellow head. (fig. 55). *Mottled fruit caterpillar.* Page 24.
6. Smooth greenish caterpillar 1½ inches long when grown, with various colored blotches and marks on the back. (fig. 11). *Saddled prominent.* Page 25.
7. Very small smooth greenish yellow caterpillars (½ inch or less), feeding upon upper surface of leaf. (fig. 14). *Apple-leaf Bucculatrix.* Page 27.
8. Hairy caterpillar with four white humps of hair on the back, and black pencils of hair on head and tail. (fig. 15).
   I. Head red. *White-marked tussock.* Page 28.
   II. Head black. *Antique tussock.* Page 28.
9. Hairy caterpillar; ground color bluish with a single line of white dots on the back. (fig. 16). *Forest tent caterpillar.* Page 30.
10. Hairy caterpillar, ground color brownish, with broken white stripes on each side when full grown; the young are in winter nests, they are brownish with 2 reddish dots on back. *Brown-tail.* Page 32.
11. Hairy caterpillar, ground color dusky; with 2 rows of red spots and 2 rows of blue spots along back and with dim yellowish stripe between them. *Gypsy.* Page 34.
12. Hairy caterpillars, when grown with long pencils of hairs at each end; when young only sparsely hairy.
   I. Body white, black spotted, hair gray or white, with spreading tufts of white hairs and decorated down the back with a row of 8 black tufts. (fig. 17). *Hickory tiger.* Page 35.

II. Body black, body hair yellow; more or less black at ends. *Spotted tiger.* Page 35.

13. Hairy caterpillars with soft hairy lappets low on the sides; a black band between joints 3 and 4 which shows when walking; warts on joint 3. *Velleda lappet.* Page 37.

14. A long-legged yellowish brown beetle feeding on the foliage. (fig. 18). *Rose chafer.* Page 38.

c. *Caterpillars living in web nests or cases in spring or summer, or concealed in folded leaf or bud.*

1. Dusky yellowish, hairy caterpillar usually with broad dark stripe along middle of back; body hairs long and dark; in colonies. (fig. 19). *Fall web worm.* Page 40.

2. Hairy caterpillar, ground color bluish, white stripe along middle of the back; in colonies. *Orchard tent-caterpillar.* Page 41.

3. Small bud-feeding caterpillar, with head and top of next segment black, body brownish. *Bud Moth.* Page 43.

4. Small smooth olive greenish or brownish caterpillar, with yellow head, black dot on each side of segment behind the head; lives in folded leaf in fall. (fig. 22). *Leaf sewer.* Page 44.

5. Caterpillar living in small cigar-shaped case (or from fall to early spring a curved case) about ¼ inch long. (fig. 23). *Cigar case bearer.* Page 45.

d. *Conspicuous winter stages. Egg masses, cocoons, etc.*

1. A small clump of dried leaves firmly tied together with silk, fastened to the twig, concealing small dark living caterpillars within. (fig. 38). *Brown-tail moth nest.* Page 32.

2. A large spindle-shaped cocoon upon the twigs with a single large brown pupa within. (fig. 37). *Cecropia cocoon.* Page 21.

3. A flat, oval, tan-colored, felt-like mass attached to tree trunks, old boards and all kinds of rubbish. *Gypsy moth egg mass.* Page 34.

4. A band of eggs encircling a twig.

I. Egg mass with rounded ends. (fig. 36). *Orchard tent-caterpillar eggs.* Page 41

II. With square ends. *Forest tent-caterpillar eggs.* Page 30.

5. Eggs adhering to a grayish cocoon; cocoon enclosing a brownish empty pupal skin. (fig. 39). *Antique tussock.* Page 28.

6. A whitish frothy mass enclosing several layers of eggs adhering to a grayish cocoon, with empty pupal skin within. *White marked tussock.* Page 28.

a. PLANT LICE.

Besides the woolly aphis which does its chief damage to the apple roots, several species of aphids attack the leaves, and tender stems. These are minute insects about 1/8 of an inch long. They pierce the tissue of the shoots with their beaks and suck the sap or infest the leaves causing them to curl, or become sickly. Some species of these pass their whole life upon the apple while others spend part of the year on other plants. But as all the important species return to the apple twigs to lay eggs in the fall and as they resemble one another closely, both in appearance and manner of injury, it is not necessary to discuss more than two species here.

Aphids are frequently attended by ants which are attracted by honey dew, a sweet secretion of the aphids, and the presence of ants about the apple leaves is a pretty certain sign of aphid infestation.

Lady beetles (figs. 52, 53) both in the adult and larval stage feed greedily upon aphids and should not be mistaken for injurious insects. Syrphus maggots also are among the most beneficial insects in the State in this respect, as they destroy aphids in great numbers.

1. Green Apple Aphis.

(*Aphis pomi* De G.)

The body is pear-shaped, the colors being yellowish green, greenish, or darker, varying considerably in detailed markings and in the several generations.

Winter eggs (fig. 30) are deposited by the sexual females in the fall. They hatch in the spring, and, like the species next considered, the aphids developing from them cause a curling of the leaves. The green apple aphis infests the apple throughout the year. Upon the hatching of the winter eggs in spring a succession of agamic generations is produced, the earlier ones, except the first, with numerous winged individuals which migrate to other trees and establish new colonies.

2. Rosy Apple Aphis.

(*Aphis pyri* Boyer.)

The rosy apple aphis, regarded by Gillette as possibly *Aphis pyri* Boyer, is readily distinguished from the preceding by its larger size, rounder body, and usually rosy color, which, however, may vary from salmon to tan or even to slaty gray or black, the body being covered with a whitish pulverulence.

Winter eggs are deposited in the autumn by sexual females, and more often on the trunk and larger limbs than with the other species mentioned. They hatch in spring as the apple leaves are pushing out, and the young aphids infest the young leaves and later the tender shoots and foliage, the latter thus becoming usually badly curled. Three generations from the egg are said to occur on the apple in the spring, many individuals of the second and third generations developing wings and migrating to other trees and to other host plants. After the third generation the apple is deserted by the insects until fall, when the return migrants appear and give rise to the true sexual forms, the females depositing eggs as described.

Methods of control.

Pruning.—As has been stated, the aphids under consideration pass the winter in the egg stage on the apple, the eggs being deposited more or less promiscuously over the more nearly terminal twigs (fig. 30). With young trees especially, which are seen to be heavily stocked with the eggs, the latter may be largely removed during the work of pruning, and the prunings should be collected and burned.

The insects in the egg condition are frequently distributed on nursery stock; therefore, if in planting trees this stock be well pruned and the prunings destroyed, the establishment of the aphids in young orchards may be often prevented or delayed.

Winter spraying for destruction of eggs.—Excellent results have followed the use of lime-sulphur wash, most all of the eggs of the apple aphis having been destroyed by one thorough application in spring shortly before the buds opened. The use of this wash for the eggs of aphids would also control the San Jose scale when present.

Spring and summer treatments.—Effective work in controlling these insects may be done in the spring just after they have hatched from eggs and have collected on the expanding foliage. Trees seen to be badly infested at this time should be thoroughly sprayed, taking pains to wet as completely as possible all parts of the leaves, twigs, and branches. However thoroughly the work may be done, some of the "lice" are almost sure to escape destruction, owing to the difficulty of forcing the spray between the unfolding leaves, more or less covered with hairs, where some of the insects will have penetrated. A subsequent treatment in the course of a week should usually be made, especially if the first application is seen to have been unsatisfactory.

After the foliage is well out and more or less distorted from the presence of the aphids, effective spraying is quite difficult, since many of the insects on the lower surface of the curled leaves will not be hit by the spray. Repeated applications must be made, therefore, as necessary to keep the insects under control.

Spray mixtures.—The lime-sulphur wash for the destruction of winter eggs is made according to the usual formula for the wash (Formula 10).

After the trees are in foliage, a more dilute contact insecticide must be employed, as strong tobacco docoction, 15 or 20 per cent kerosene emulsion, or whale-oil soap (Formulas 8, 4, 6). Since aphids secure their food by sucking up sap from within the plant, none of the arsenical poisons would be effective.

b. INSECTS FEEDING FREELY UPON THE LEAVES WITHOUT A NEST AND NOT CONCEALED WITHIN LEAF OR BUD.

1. Canker Worms.

1. SPRING CANKER-WORM.

(*Paleacrita vernata.*)

The male moths of this species have rather large, thin, silky wings, about one inch across when spread. The general color is bluish gray. A well defined row or band of light markings near the outer margin of the front wings, and three darker, irregular bands, across the same wings, together with the

slightly lighter color and absence of markings on the hind wings, are characteristic features. The inconspicuous female moths are wingless and, because of this fact, the spread of the species is very slow, occurring mainly by the transportation of nursery stock infested with eggs.

The moths usually emerge from the ground early in the spring—about April, or farther south, in March—and the females climb up the trunks of trees to deposit eggs. The eggs, which are shaped something like hens' eggs and are about the size of fly specks, are deposited in irregular masses, usually partially concealed by loose pieces of bark. They hatch about the time the leaves unfold; the time varying with the locality and the season. The larvæ are "measuring worms" with 2 pairs of legs at the hind end of body (fig. 5). The young larvæ are

Fig. 5. a, larva, showing the two pairs of posterior legs; b, single egg, much enlarged. (After Riley).

voracious feeders and they grow rapidly, usually attaining full size in from three to four weeks from the time of hatching. Upon reaching full size they drop to the ground, burrowing beneath the surface to a depth of two to five inches. Here each one forms a cell, lined with silk which it spins, and soon transforms to the chrysalis stage, where it remains until the following spring, when the adult moth emerges as before.

II. FALL CANKER-WORM.

(*Alsophila pometaria.*)

The fall canker-worm so closely resembles the other species as to be frequently mistaken for it. For all practical purposes they may be considered together, but the fall canker-work is more distinctively a northern insect. As in the other species, the female moth is wingless, but in this species she lacks the hairiness which characterizes the other. The male moth has two light bands across the front wings instead of the single one of the preceding, and the rear wings are slightly shaded. The larvæ of this species also, besides having three pairs of legs under the hind end of the body, as shown in figure 6, have a broad, dark stripe along the back, as opposed to the narrow

markings of the other species. The eggs, which are slightly larger than in the previous species, somewhat resemble small flower pots and are attached to the bark, in exposed situations, in masses of from 60 to 200, placed side by side as seen in figure 6, *e*. The eggs highly magnified, are shown in figure 6 *a*.

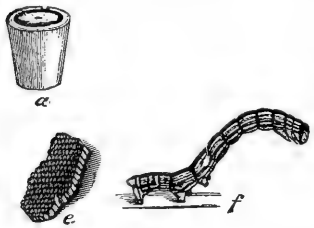

Fig. 6. a, single egg, much enlarged; e, egg mass; f, larva, showing the three pairs of posterior legs. (After Riley).

The eggs are deposited in fall or early winter (sometimes in mild winters as late as March). They hatch about the same time as those of the other species and the larvæ act in a similar manner, entering the ground about the same time. Instead of forming a cell lined with silk, however, this species spins a tough cocoon, and the moths come forth and begin laying eggs in October and November.

HOW TO FIGHT CANKER-WORMS.

One of the surest preventive measures is to place a band of tarred paper about the tree in March and smear it with tree tanglefoot, thus preventing the ascent of the female moths and the deposit of eggs. In case the bark is very rough, it should be scraped smooth to prevent the insects from crawling up behind the paper. If the fall canker-worm is present, of course the treatment must begin in October. If the trees are already attacked, jarring the limbs will cause many of the worms to spin a thread and drop to the ground. If the band of tanglefoot is in place they will be unable to return to the attack and may be destroyed.

The surest way of fighting this pest, however, is by spraying with Paris green or arsenate of lead (Formula 3). For this purpose the pump should be powerful enough to develop a pressure of at least 60 pounds to the square inch, and all parts should be made of brass and carefully adjusted.

2. Cecropia Moth.

(*Samia cecropia.*)

The large gray or brown cocoon of the Cecropia moth is frequently found attached to the twigs of trees (fig. 37).

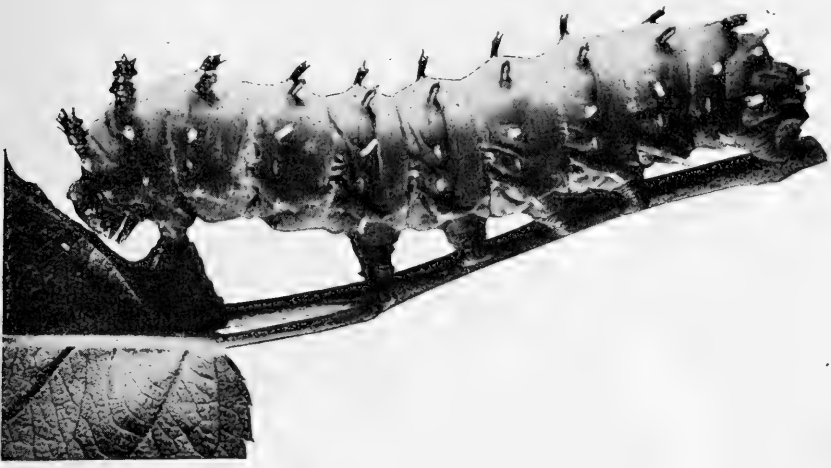

Fig. 7. (From Me. Agr. Exp. Sta. Circular).

These are spun late in August or September by a green caterpillar about four inches long. The body of the caterpillar is ornate with colored bead-like tubercles, the two pairs nearest the head being red with black spines, and the other dorsal tubercles smaller and yellow. Along the sides of the body the tubercles are bluish. (Fig. 7).

After the cocoon is spun the caterpillar changes to the pupa, a dark brown object which may be found by opening one of the cocoons during the winter.

In the spring the insect breaks open the brown pupal skin and emerges from the cocoon as the adult insect, the largest moth in the state and one of the most beautiful. Its expanded wings measure about five and one-half inches. In color the wings are brownish with a border of gray and submarginal lines of white and red. The form of the markings is better represented by the accompanying illustration than by a description.

The caterpillar is well attended by insect parasites and is devoured by birds. In this State it has not occurred to a

troublesome extent and need not be feared as a pest, although it feeds on apple and various forest trees. No remedies usually seem necessary. If the caterpillars are found upon a small trees which they are likely to injure, hand picking will prove effectual.

Those who find the Cecropia cocoons during the winter are often interested to save them in a warm room for the sake of observing the beautiful moth which emerges (fig. 8).

Fig. 8. (From Me. Agr. Exp. Sta. Circular).

3. Yellow-Necked Caterpillar.

(Datana ministra.)

During the late summer the yellow-necked caterpillar is a common orchard pest in Maine.

The moth is tannish brown in color with head and the part of the thorax nearest the head a rich chestnut brown. Several dark brown lines cross the fore wings transversely. The hind wings are pale buff. The female moth deposits about 100 eggs in a cluster on a leaf.

The caterpillars which hatch from these eggs, attain their full growth in 5 or 6 weeks. They are then about two inches long. The head is black and the segment just back of the

head is orange colored, a character which gives rise to the popular name "yellow-neck." The body is striped longitudinally with alternate yellow and black lines. Soft white hairs occur over the whole body but are too thin to be especially noticeable (fig. 9). Like the red-humped caterpillar, these caterpillars are clustered together both while feeding and when at rest. The caterpillars when at rest assume a characteristic and peculiar position on the branch with both extremities of the body raised. When alarmed they jerk their heads and tails in an irritated manner.

Fig. 9. (After Holland).

The full grown caterpillars bury themselves in the earth a few inches below the surface, where they transform into brown pupæ, unprotected by any cocoon. They remain in the earth all winter and emerge about the middle of the next summer, when they are transformed to the moth, or mature insect.

REMEDIES.

As in the case of the red-humped caterpillar, gathering the caterpillars by hand is the simplest remedy and perhaps the only one which it is necessary to recommend. The caterpillars are gregarious and the whole brood is easily removed from the tree and destroyed. Arsenical sprays (Formula 3) will kill them, and may sometimes be a convenient means of combating them.

4. Red-Humped Caterpillar.

(*Œdemasia concinna.*)

During August, September and October, the red-humped caterpillar is one of the most troublesome orchard caterpillars in the State. Many correspondents reported that entire orchards of young trees were stripped of their foliage, except for the mid ribs of the leaves, before the presence of the pest had been discovered.

Fig. 10. (From Me. Agr. Exp. Sta. Circular).

The mature insect is an inconspicuous brown moth with wing expanse of slightly more than one inch. The female deposits eggs on the under side of a leaf in a cluster, usually during July. The young caterpillars, which soon hatch from these eggs, feed upon the tender tissues of the under side of the leaf, not attacking at first the upper surface. When they become larger they devour the whole leaf except the mid rib. They move in flocks, an entire brood feeding together and remaining in a cluster when resting. In the caterpillar or larval stage this insect is readily recognized. The body of the full grown caterpillar is marked with fine longitudinal stripes of black, white and yellow, and short black spines occur in rows. The head is bright red and the first segment of the abdomen, which is conspicuously humped, is of the same color (fig. 10). The caterpillars reach their full growth (about 1¼ inches) from August to late October. When full grown, they descend to the ground and hide under leaves or other rubbish and make a glassy transparent cocoon, within which they pass their pupal period. They remain in the cocoon all winter and emerge the following season as mature moths.

REMEDIES.

The red-humped caterpillars are not especially difficult to combat if a watch is kept for the colonies while they are young. As they are gregarious, it is a simple matter to clip off the small twig containing the whole brood of little caterpillars. When they are larger they can often be dislodged by jarring the branch and destroyed on the ground. Arsenical sprays (Formula 3) will kill them, but the presence of fruit makes this remedy undesirable for bearing trees late in the season.

5. Mottled Fruit Caterpillar.

(*Crocigrapha normani.*)

The eggs are laid in a mass flatly attached to the leaf. They hatch in mid-June in Maine. The larva is a smooth, hairless caterpillar, 1½ inches long when full grown. Its head is shiny

yellow with one dark blotch on each lobe. Its body is mottled grayish brown above, and pale grayish green beneath. The legs are pale. This caterpillar feeds both upon the foliage and the fruit. (See fig. 55). The pupal stage is passed in the ground. It is a glistening brown object about ¾ inch long. The mature insect is a brownish moth expanding about 1½ inches.

REMEDIES.

Arsenical sprays (Formula 3) applied for other species will control this one also. As this caterpillar is very readily dislodged, jarring the tree and killing the insect on the ground is a convenient combatative measure.

6. Saddled Prominent.

Heterocampa guttivitta (Walker).

This species is well known in Maine because it has been excessively destructive to orchard and forest trees during some seasons. The full grown caterpillar is about 1½ inches long; body green usually, with reddish brown markings on the back, smooth and hairless (fig. 11). The mature insect is a moth expanding about 2 inches, ground color olive-greenish ashen with cream white patches and black markings (figs. 12, 13).

For Maine the saddled prominent has but one brood. The moths emerge in greatest numbers late in May and early in June. Oviposition begins soon after mating which occurs the first night after emergence. The eggs hatch in about 9 days and the larvæ become full grown in 5 weeks (or more according to weather conditions and food supply). During this time they molt four times. The full grown larvæ enter the ground for pupation. In Maine pupation takes place from mid July to late August, the majority of larvæ burying late in July. They pass the winter in the pupal stage, under the leaf mold, and the moths emerge in the spring.

The eggs are deposited singly by the female which in captivity applies the eggs to both sides of the leaf. From the reason that the *tops* of the trees are stripped first and then the lower branches it is to be concluded that the moths by preference deposit the eggs upon the upper leaves. Perhaps the same tendency to fly high may account in part for the fact that the

hillside forests are in general more largely attacked than the lowlands.

The full grown larva drops or climbs to the ground and constructs a cell in the earth or under the leaves at a distance of 1 to 3 inches below the surface. This cell is oval and is lined by a thin spinning of silk.

The insect after remaining in the pupal stage all winter emerges with the warm spring days.

FIG. 11. (After Packard).

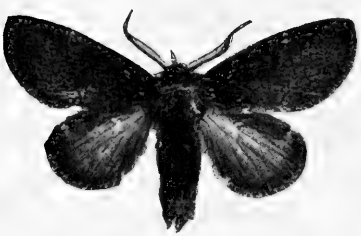

FIG. 12. Male.

FIG. 13. Female.

(FIG. 12 and 13 from Me. Ag. Exp. Sta. Bul. 161).

COMBATATIVE MEASURES.

For the orchard or shade trees there are several practical measures which have proven successful the past season in preventing serious injury from the saddled prominent.

Spraying.—This species is susceptible to arsenical poisons and the caterpillars readily died on apple trees which were thoroughly sprayed. Arsenate of lead or Paris green (Formula 3) will kill these caterpillars and should be applied as soon as they begin appreciable work. Applications from the middle to the last of June would probably get all these caterpillars which hatched upon the trees. In case a migration to an orchard from an infested forest growth is feared, the orchard should be sprayed as soon as the caterpillars begin to travel in search of fresh food. If trees not already attacked are banded with a sticky substance, the ascent of caterpillars up the trunk will effectually be prevented.

Jarring and banding.—The saddled prominents are readily shaken from the branches. The cool of the morning is the most propitious time for jarring. The caterpillars once dislodged, their reclimbing can be prevented by banding.

A material useful for this purpose is sold under the name of Tree Tanglefoot. This substance consists principally of resin softened by the admixture of suitable oils. It is quite similar to that used in the manufacture of adhesive fly-paper, seems to possess the merit of not injuring the trunks of trees, and is very effective in checking the ascent of caterpillars thereon. Where the number of caterpillars jarred from the trees is excessive it is expedient to kill them. A hand spray charged with kerosene or gasoline is a useful means to this end.

Fowls and Pigs.—Hens will devour these caterpillars greedily and if given the range of an orchard will eat great numbers of the caterpillars which drop to the ground or descend to pupate.

Pigs pastured in an orchard will, by rooting up and eating the pupæ, prevent great numbers of saddled prominents and other moths from emerging and depositing eggs for the following season.

7. Apple-Leaf Bucculatrix.

(*Bucculatrix pomifoliella.*)

The larva of this insect is about one-half inch long when mature, cylindrical, tapering at both ends. Joints of the body rounded and prominent, color dark yellowish, with a greenish tinge and reddish shades on the anterior segments. The larvæ are active and when disturbed suspend themselves by a silken thread.

The cocoon is dirty white, slender, about one-fourth inch long, ribbed longitudinally by about six prominent ridges, oblong, tapering at both ends, flattened on the side to which it is attached. Usually fastened to the twigs and branches in groups. (Fig. 14).

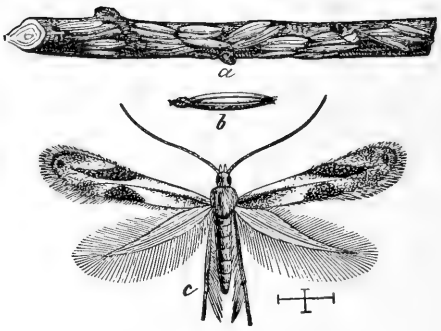

FIG. 14. (After Riley).

The small moth has only about one-fourth inch expanse of wings. Fore wings whitish, tinged with pale yellow and dusky brown. (Fig. 14).

This insect spends the winter in the pupa state in the cocoon, usually attached to the twigs and branches of the host plant. About the time the leaves unfold, the moths come forth and lay their eggs upon the tender foliage. The larvæ are full grown in July.

In September or October the cocoons in which the pupæ spend the winter are formed. The larvæ feed externally upon the foliage, the upper epidermis and pulp eaten away in patches, the veins and lower epidermis intact.

REMEDIES.

Jar the trees when the larvæ are full grown and they will suspend themselves by threads and can be swept down by a broom and killed by hot water or crushed.

Apply kerosene emulsion with a spraying pump in winter, to the branches that bear the cocoons. The same application might be made for the first brood when the foliage is on.

Spray with arsenical poisons (Formula 3) as for other leaf-eating insects.

8. TUSSOCK MOTHS.

I. WHITE-MARKED TUSSOCK (*Hemerocampa leucostigma*).

II. ANTIQUE TUSSOCK (*Notolophus antiqua*).

The conspicuous white egg masses of these moths are deposited late in the summer or in the fall upon the cocoons from

which the female moths emerge. As the hairy cocoons are commonly attached to the rough bark, or twigs of trees the caterpillars infest, the egg-masses are readily found at any time after the leaves have fallen. The eggs which the white-marked tussock deposits are covered with a white frothy substance which becomes brittle upon exposure to the air. The antique tussock does not protect its eggs in this manner but leaves them uncovered upon the cocoon (fig. 39).

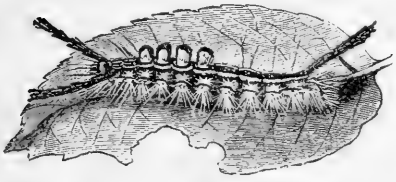

Fig. 15. (After Riley).

The caterpillars which emerge from these eggs in the spring are most grotesque in appearance. The caterpillar of the white-marked tussock moth when full grown has a shiny coral red head beyond which extend two stiff pencils of black hairs directed forward like horns. A single pencil of similar construction supplies the other end of the body with a tail. Upon the middle of the back, starting a little behind the head, is a row of four regular tufts of soft whitish hairs which resemble small paint brushes neatly trimmed off at the tip. In a line with these but nearer the tail occur two little bright red tubercles (fig. 15). The full grown antique tussock caterpillar resembles closely the species just described. Its head, however, is jet black and it has an additional pair of black pencils, similar to though shorter than the horns, projecting from the sides of the body, which is lacking in the caterpillar of the white-marked tussock.

After feeding for four or five weeks the caterpillar becomes full grown and spins a rough cocoon of silk with which it mixes the hairs that have decorated its body. These cocoons are usually formed upon the bark or in the angles of twigs. Often a leaf is attached to the mass.

In about two weeks the adult insects emerge from the cocoons. The males are winged, the white-marked tussock having gray wings which expand nearly one and one-half inches and the antique tussock having smaller brown wings. The female

moths of these two species are not readily distinguishable. They never acquire wings and their distended bodies are practically little more than animated sacs of eggs. The females being unable to fly and their bodies being too heavy for their slender legs to drag about, cling to the cocoons from which they emerge and soon after mating deposit about 300 eggs in a mass upon the cocoon.

REMEDIAL MEASURES.

The white egg masses deposited on the cocoons remain on the trees all winter. These are readily seen and can be removed and burned. Cocoons of the tussock not covered with eggs should not be disturbed as they are either the empty cocoons of males or cocoons containing parasites. If the cocoons are empty they can do no harm and if they contain parasites, these insect enemies of the tussock should be allowed to develop.

The fact that the females cannot fly makes this pest easily controlled locally, for the orchardist need not especially fear his neighbor's infested trees.

The caterpillars are susceptible to arsenical sprays (Formula 3) and this means of combating them is sometimes necessary where the winter collecting has been neglected or when the tussocks appear in destructive numbers upon shade trees.

9. Forest Tent Caterpillar.

(*Malacosoma disstria.*)

The eggs of this insect are deposited in a belt encircling a small twig, about 200 in each mass. These egg masses resemble those of the orchard tent caterpillar, except that they are more nearly square at the ends. A glistening varnish-like protective substance is deposited with the eggs which renders the mass more readily seen in the sun.

The colonies of young larvæ do not construct tents as do the orchard tent caterpillar, but they are usually massed during dark or rainy weather.

The caterpillars resemble the orchard tent caterpillars, the most striking difference being that the cream colored line along the back is broken into a line of dots in the forest tent caterpillar while with the orchard tent caterpillar this line is unbroken. They grow to be about two inches long.

The full grown caterpillar constructs a filmy outer cocoon with an inner firm cell which it soaks with a yellow discharge drying to a pale yellow powder. These cocoons are often attached to buildings.

Moth.—In from 10 to 14 days after spinning the cocoon the adult insect emerges. This yellowish-brown moth resembles that of the orchard tent caterpillar closely but the transverse bands on the wings are darker than the ground work of the wings instead of paler as with the other species. It is not practicable to combat the insect in this stage.

REMEDIAL MEASURES.

Arsenical sprays (Formula 3) applied early in the season will satisfactorily dispose of this pest and for orchard or shade trees protected in this manner no other means are necessary. After the caterpillars are half grown it is their custom to congregate in great masses on the trunks of the trees while they molt their skins. Here they may be destroyed by a stiff broom dipped in kerosene or swept into a pail of water and kerosene.

When not congregated for molting the older caterpillars when not feeding stretch out motionless along the branches or trunk and are difficult to see, especially as they are likely to choose the upper side of the branch.

However, it is not necessary to wait for the molting periods in order to combat the older caterpillars on trees which have not been protected by spraying. These caterpillars drop downward when disturbed. "This habit leads to the suggestion that by a combination of jarring and banding much injury may be prevented." After the caterpillars are jarred from the tree the trunks of trees are painted with a band of "tanglefoot" such as is used against the gypsy caterpillar to prevent their ascending.

FIG. 16. Forest Tent Caterpillar. (From. Me. Ag. Ex. Sta. Circular).

10. Brown-Tail Moth.

(Euproctis chrysorrhœa.)

The caterpillars of the brown-tail moth are capable of ruining orchard, shade and many woodland trees. They are also a dreaded nuisance, because the caterpillar hairs break off, and on coming in contact with the human skin, cause extreme irritation and often illness.

So serious a pest should be known by every one in the State, because although extermination of this insect may not be possible, much practical and effectual work can be done in holding it in check and reducing its numbers so that damage to orchard and shade trees may be very slight.

The moths, expanding from one and one-fourth to one and three-fourths inches, are white except for the abdomen, which is tinged with brown and tipped with a tuft of brown hairs. This tuft is small and dark in the male, but the large golden-brown tuft in the female is conspicuous enough to be the most striking characteristic of the moth, and has won for this insect its descriptive name of "brown-tail." These moths are on the wing in July, and unlike some closely related pests, the brown-tail females as well as the males are strong fliers. They are active at night, and as lights have an attraction for them, they sometimes fly a long way toward a lighted district.

The female usually selects a leaf near the tip of the branch on which to deposit from one hundred and fifty to three hundred eggs. Some of the brown hairs from the abdominal tuft adhere to the egg-mass and give it the appearance of a brown felt lump.

By the middle of August most of the eggs are hatched and the young caterpillars spin a slight web over the leaf near the egg cluster. When they have eaten all but the skeleton of the first leaf, they draw another into the web and repeat the process at intervals during the late summer. They feed slowly, however, and spend so much time spinning their web that they do comparatively little damage to the trees in fall, and they are still very small (about one-fourth of an inch in length) when cold weather comes on.

The winter nests.—(Fig. 38). In the fall the young caterpillars weave additional layers of silk about their retreat, fas-

tening it securely to the branch by the web, and pass the winter thus in colonies of one hundred and fifty to three hundred in a single nest. This is a very unusual yet most commendable habit in a caterpillar pest, for they can be killed, hundreds at a time, simply by burning the nests in which the colonies hibernate. The nests, composed of leaves, bound firmly together by a silken web, are varied in shape. In spite of the superficial variety the essential characteristics of the brown-tail moth nests are soon learned, and even anyone unfamiliar with the nest can make himself perfectly certain if he will cut carefully into the nest. *If the structure contains one or more silken cells filled with tiny living caterpillars it is the winter nest of the brown-tail moth.*

Early in the spring the young caterpillars emerge from their winter nests and feed upon the opening leaf buds. Until about the middle of June they feed greedily upon the leaves, completely stripping the trees where they are numerous. When full grown the caterpillars are about one and one-half inches long. They are dark brown with a sprinkling of orange. Long fine reddish-brown hairs cover the body, and a row of conspicuous white hairs runs along each side. Like the caterpillars of the tussock and gypsy moths, they bear bright red tubercles on the top of the sixth and seventh abdominal segments.

Poisonous qualities of the caterpillars.—Were the caterpillars to be feared only for their ravages upon orchard and other trees, the situation would be alarming enough, but not less serious is the physical discomfort experienced by people living in infested districts. When the minutely barbed hairs of the caterpillar come in contact with the skin they cause an eruption similar to and in many cases worse than ivy poisoning. These hairs are brittle and where the caterpillars are numerous few people are likely to escape, as the caterpillars drop from the branches and creep about, even entering houses. Direct contact with the insects themselves is not necessary, however, for when the caterpillars shed their skins the molts are blown about, widely scattering the barbed hairs.

The caterpillars are usually full grown in June. They then spin loose cocoons, attached commonly to leaves, though sometimes other shelter is sought. Within these they transform to

brown pupæ about three-fourths of an inch long. From the first to the twentieth of July the moths with pure white wings and brown-tipped abdomens emerge from these cocoons to deposit eggs for the next generation of caterpillars.

REMEDIAL MEASURES.

Destruction of breeding places.—Old and worthless orchard trees, wild cherry tangles and other susceptible trees in infested regions should be cleared away, thus lessening the labor of direct search for the destruction of winter nests, by eliminating likely breeding places.

Cutting and burning the winter nests.—This is the most important of the direct remedies because it is the easiest, cheapest and, if thoroughly done, a sufficient protection against the ravages of this pest. The webs and leaves that compose the nest are woven tightly to the tips of the branches and hang there like dead leaves all winter. With so many months for inspection there is no excuse for harboring the hibernating caterpillars on shade or orchard trees. After they are cut from the branches the nests should be burned, as this is the simplest way of destroying the colony within.

Spraying.—The young caterpillars can be killed by arsenical sprays (Formula 3). This remedy is most effective when applied as soon as the leaves develop in the spring. Of course where the winter nests have been destroyed there will be no need of this remedy and it is much easier to kill about two hundred caterpillars enclosed in a nest than to wait until they are scattered over the tree.

11. Gypsy Moth.

(*Lymantria dispar.*)

Unlike the brown-tail moth, the gypsy moth winters in the egg stage. Although winged, the female gypsy moth does not fly, but deposits the eggs in any convenient place to which it can crawl. The egg masses are most commonly attached to the bark of trees but they are also found in such places as under edges of stones, beneath fence rails, on buildings, and in old cans and rubbish. The eggs are laid in July and August in a mass of 400 to 500. They are covered with tan colored hairs from the body of the female moth, and form an irregular oval mass.

As the eggs do not hatch until about May 1, eight months at least are available for their destruction.

The young larvæ or young caterpillars are dark in color and well furnished with dark hairs. The full-grown larva is between 2 and 3 inches long, dark brown or sooty in color, with two rows of red spots and two rows of blue spots along the back, and with a yellowish but rather dim stripe between them. The body generally is clothed with long hairs, and sometimes reaches the length of 3 inches.

The larvæ usually become full grown about the 1st of July, and then transform to pupæ. The pupæ are found in the same situations as those we described for the egg clusters, but are found also in the foliage of trees and shrubs.

The male moth is brownish yellow in color, sometimes having a greenish-brown tinge; it has a slender body, well-feathered antennæ, and a wing expanse of about an inch and a half. The forewings are marked with wavy zigzag darker lines. It flies actively all day as well as by night.

The female moth is nearly white, with slender black antennæ, each of the forewings marked with three or four zigzag, transverse, dark lines, and the outer border of both pairs of wings with a series of black dots. The body of the female is so heavy as to prevent flight.

REMEDIAL MEASURES.

Killing the Eggs.—"No single method of destruction against the gypsy moth is more effective than killing the eggs. The egg masses, wherever accessible, can be killed from August to May by soaking them thoroughly with creosote mixture. The creosote may be applied with a small swab or paint brush. Creosote mixture may be purchased at agricultural warehouses and seed stores at from 50 cents to $1.00 per gallon, depending on the quantity."

The caterpillar can be controlled by arsenical sprays (Formula 3).

12. Tiger Moths.

I. HICKORY TIGER MOTH (*Halisidota caryæ*).

II. SPOTTED TIGER MOTH (*Halisidota maculata*).

These two closely related insects are so similar in habits and

are so commonly associated in Maine orchards that they may be discussed together.

The hickory tiger caterpillars are, when full grown, covered with spreading tufts of white hairs and decorated down the back with a row of 8 black tufts. The fourth and tenth segments each bear two long slender pencils of black hair.

The caterpillar of the spotted tiger moth is yellow and black, these colors occurring in widely variable proportions. Sometimes the whole body is covered with yellow hairs in which case there is a row of 8 tufts of black along the back as with the hickory tiger. Often, however, both ends of the caterpillar are covered with black hairs with scattering pencils of white and the yellow hairs are limited to the central portion of the body. Both the hickory tiger and spotted tiger caterpillars have jet black heads and legs.

The young tiger caterpillars are only sparsely supplied with hairs and bear very little resemblance to the fuzzy full grown ones. They are gregarious when young and at first their presence may be detected by skeletonized leaves but later the colony scatters and the caterpillars feed separately, eating the whole leaf substance. If they are disturbed they curl up like a hedgehog and drop to the ground. The hairs are easily brushed from the body of these caterpillars and cause, upon contact with sensitive skin, an irritating itching sensation.

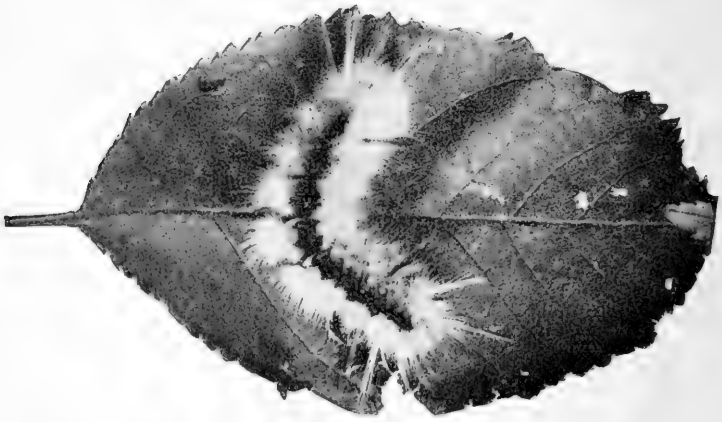

FIG. 17. Caterpillar of hickory tiger moth. (From Me. Agr. Ex. Sta. Circular).

They feed until they are nearly one and one-half inches in length and then they leave the trees and seek suitable shelter for their cocoons, the sides of buildings often being selected. The cocoons are oval, snug little objects less than an inch long and are composed almost entirely of the hairs which have covered the caterpillars, closely felted together. Within the cocoon the insect remains all winter—as short, thick, rather blunt brown pupæ.

The winged moths emerge from the cocoons in June and deposit their egg clusters upon some suitable food plant. The hickory tiger moth is pale buff. The fore wings are thickly sprinkled with little brown dots and set with irregular yellowish white spots. The hind wings are unmarked. The spotted tiger moth resembles the related species closely, but the spots are variable in size and number.

REMEDIAL MEASURES.

Arsenical sprays (Formula 3) will poison these caterpillars. However, where trees are carefully watched, the colonies of the tiger caterpillars could be easily removed by hand while they are young and congregated together. Sometimes, too, it is possible to get rid of them by jarring them off on to a sheet. Where they form cocoons along the edges of clapboards and in other crannies about buildings, much can be done by sweeping down the cocoons and destroying them.

13. Velleda Lappet Moth.

(Tolype velleda.)

The larva of this insect is remarkable for having on each side of each segment a little lappet or flat lobe; from these many long hairs are given out, forming a fringe to the body. It is bluish gray, with many faint longitudinal lines; and across the back of the last thoracic segment there is a narrow velvety black band. When at rest the body of the larva is flattened, and the fringes on the sides are closely applied to the surface of the limb. The larva is full grown during July. The cocoon is brownish gray, and is usually attached to a branch of the tree. The body of the moth is milk white with a large blackish spot on the middle of its back, the wings are a soft bluish gray crossed by white lines. The moths have an expanse of wing ranging from 1¼ to 2 inches.

REMEDIAL MEASURES.

It is rarely necessary to apply repressive measures. Arsenical sprays (Formula 3) will control these insects.

14. Rose-Chafer.

(*Macrodactylus subspinosus* Fab.)

The rose-chafer (fig. 18), a long-legged beetle of a light yellowish brown color, and about a third of an inch in length, appears in June, the date varying somewhat according to locality and season, and the beetles mate and begin feeding soon after they emerge from the ground. For from four to six weeks after their appearance they continue feeding, almost constantly paired. The female deposits her eggs singly, from twenty-four to thirty-six in number, a few inches beneath the surface of the earth, and in about two or three weeks' time they hatch and the young larvæ or grubs begin feeding on such tender rootlets, preferably of grass, as are in reach. In autumn they have reached maturity. They are yellowish white in color, with a pale brown head. Late in autumn they descend lower into the earth, beyond the reach of frost, and in early spring they ascend, and each grub forms a little earthen cell in which it passes the winter. Later in the spring, in April or early May, they transform to pupæ, and in from two to four weeks afterwards the beetles emerge, dig they way out of the ground, and the destructive work is renewed. A single generation of the species is produced in a year, and about three weeks is the average duration of life for an individual insect.

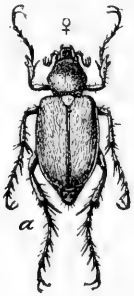

Fig. 18. (After U. S. Div. of Entomology).

The beetles do not confine their ravages to any particular portion of a plant, but consume blossoms, leaves, fruit, and all alike (fig. 41, 42). Whole orchards are often devastated, and the fruit crop of large sections of country destroyed. It is no uncommon sight to see every young apple on a tree completely covered and obscured from view by a sprawling, struggling mass of beetles.

REMEDIES.

The rose-chafer is one of our worst insect enemies to combat successfully. The difficulty is that any application that may be made is unsuccessful unless applied almost continually. The arsenites will kill the beetle, but are not of much value when the insects are abundant, because of the slow action of the poison. Every beetle on a plant might be destroyed one day, but on the day following the plant would be completely covered again.

They may be jarred from trees on to sheets saturated with kerosene, but these methods are tedious and must be practiced daily in early morning or toward sundown to be effective.

Small orchards may be protected, at least from the first arriving hordes of the chafers, by planting about them early-flowering plants that particularly attract the beetles. Spiræas, Deutzias, Andromeda, magnolias, blackberries, and white roses are especially useful as counter-attractives. The beetles swarm on the flowers of these plants in preference to many varieties of fruits, and when thus massed in great numbers, their destruction by the use of collectors or other mechanical means is greatly facilitated. All ground which might serve as a breeding place and which it is possible so to treat, should be plowed and harrowed early in May for the destruction of the larvæ or pupæ.

c. CATERPILLARS LIVING IN WEB NESTS WHILE THE TREE IS IN LEAF, OR MORE OR LESS CONCEALED IN FOLDED LEAF OR BUD.

1. Fall Web Worm.

(Hyphantria cunea.)

Fig. 19. (After Riley).

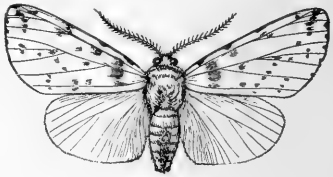

Fig. 20. (After Howard).

The mature insect is a moth with a wing expanse of about 1½ inches. It varies much in coloration but the most common form is white or slightly fulvous with white wings. The wings may be pure white or dotted with black and brown. In the spring the moths emerge from the cocoons in which they have passed the winter and the female deposits eggs upon a leaf in May or June. Each moth lays from 400 to 500 eggs from which hatch minute caterpillars in 10 days or more according to weather conditions. These caterpillars remain together and cover themselves with a small silken web. As they grow, more and more leaves are drawn into the web which may in time include the leaves of several small branches or all upon a large branch. Such webs sometimes attain dimensions of several feet and are conspicuous and unsightly masses.

If they are so numerous on one tree that the food supply gives out they leave the web and seek other trees. Otherwise they remain until they are full grown (a little more than an inch in length), when they drop to the ground and seek a place where they may make cocoons. Recesses which attract them for this purpose are crevices in bark, spaces under boards or door steps, or near the surface of the ground in rubbish. These insects pupate within thin, almost transparent cocoons and remain in them all winter, emerging as mature moths in the spring.

REMEDIAL MEASURES.

Trees well protected with arsenical sprays (Formula 3) will not need other treatment for fall web worm, for the poisoned leaves will be drawn into the web for food. In many cases the simplest means for combating them is to keep close watch upon the trees and clip off and burn the web when it is still small. Even the full sized web can be pruned off from trees not valuable, but in the orchard there is, of course, no excuse for allowing them to remain until large branches are involved in the web. The web may be effectually drenched with a strong washing powder solution or kerosene emulsion.

2. Orchard Tent Caterpillar.

(*Malacosoma americana.*)

Encircling the twig of apple, plum, and wild cherry trees is frequently found a glistening brown mass about three-fourths of an inch in length (fig. 36).

From such an egg cluster hatch in the spring from two hundred to three hundred caterpillars, which live in a colony and construct a whitish tent-like web in the angle of two convenient branches. It is the habit of the tent caterpillars to pass their time when not feeding, particularly at night and during cold or stormy weather, within the tent which they enlarge as their own rapid increase in size calls for more room. During the warm sunny hours of the day they leave their protection and feed voraciously, defoliating the branches in the vicinity of the tents. One colony is enough to denude a young tree or several large branches of an old tree.

The tent which is at first a delicate filmy silken web becomes by the time the caterpillars are full grown a structure two feet or more in length, unsightly with the accumulation of molted skins and other rubbish.

The full grown caterpillar is nearly two inches long. It is slender, dark, and velvety with numerous soft golden brown hairs upon the body. A white stripe marks the middle of the back, while the sides are streaked irregularly with white or yellow. Along each side of the dorsal white line is a row of transverse pale blue spots.

After feeding for four or five weeks the caterpillars leave the tree in search of a sheltered place for their cocoons, a crevice in the bark, the eaves of buildings, or rubbish piles, proving attractive for this purpose. The cocoon is an elongated oval with the outer silk delicate and loosely woven and the inner part firmer and close. The inner cell is painted on the inside with a thick yellow liquid which soaks through the cocoon and soon dries to a yellow powder.

The insect remains in the cocoon from two to three weeks, when it emerges as a brown moth expanding about one and one-half inches. The fore wings are crossed obliquely by two pale lines. The general color of the moth varies from buff to reddish brown in different individuals.

FIG. 21. Female moth photographed in resting position; slightly enlarged.

REMEDIES.

This insect is so easy to combat that its presence to any great extent in an orchard is due largely to negligence. During the bright days of winter and spring the egg masses are readily detected on young twigs as their varnished surfaces glisten in the sun. These should be removed and burned.

Since the caterpillars congregate in their tents at night and are not early risers, they can be destroyed, the whole colony at once, by soaking the tent with kerosene emulsion, or soap or washing powder suds (Formulas 4, 7). This may be applied by a swab attached to a pole. Any time when the whole family is "at home" is suitable for this remedy, as the early morning, evening, or a cold or cloudy day.

Arsenical sprays (Formula 3) will kill the caterpillars and may be applied to the branches near the tents. Trees sprayed early in the spring for the bud moth and other early caterpillars will be sufficiently protected against the tent caterpillar also.

3. Bud Moth.

(*Tmetocera ocellana.*)

This is probably one of the worst pests to apple orchards in Maine. It works in the unfolding flower and leaf buds of orchard trees, often doing great damage to the crop, besides attacking nursery stock and young trees.

The half grown, brown, hibernating caterpillars usually emerge from winter quarters about the time the buds begin to expand, their first appearance depending on the advance of the season, and ranging over two or three weeks. When they are out early, they gnaw into the buds. If the buds are open they crawl inside. They attack both flower and leaf buds, fastening the parts together with silken threads forming a nest, within which they feed upon the enclosed tender flower or leaf parts. They do not confine their depredations to a single leaf or flower in the bud, but increase the injury done by sampling nearly all. They sometimes bore down the stems a few inches, killing the terminal shoots. The bud attacked turns brown, making the nest conspicuous. The caterpillars feed mostly at night for 6 or 7 weeks and moult 3 times. When full grown the caterpillar forms a tube out of leaves, which it lines with thin, closely woven silk, and within it soon changes to the pupa. In about 10 days the pupa works its way nearly out of the tube by the hooks on its back. The skin splits open and the moth appears. The moths are on the wing during the latter part of June and the first of July. They fly mostly at night, resting on the trees during the day time, when they may be easily recognized by the white bands on the ash colored wings. The moth has a wing expanse of 3-5 of an inch. They live 2 or 3 weeks, during which time they mate and the eggs are laid. The eggs, which resemble small fish scales, are laid singly or in clusters, mostly at night, on the under side of the leaves. The eggs hatch in 7 to 10 days. The young larvæ feed upon the epidermis of the leaf, forming a silken tube for protection. After the fourth moult, which occurs the last of August or the first of September, or before the leaves fall, they leave the silken tubes and form a silken winter home (*hibernaculum*) on the smaller twigs near the buds, in which they spend the winter. The appearance of the hibernating larva in the spring completes the cycle of life.

REMEDIES.

Pull off and burn the withered clusters of leaves containing the caterpillars and chrysalids early in spring. Spray with arsenate of lead (Formula 3) as soon as the buds begin to swell in the spring. It will not do to wait until the attack is made.

4. Leaf Sewer.

(*Ancylis nubeculana.*)

The leaf is folded along the mid rib, the two sides being brought together, the caterpillar constructing its nest within (fig. 22). The winter is passed in the larval condition in the folded leaves which lie on the ground. In April the larvæ transform to pupæ and about 10 days later the moths begin to appear, laying eggs in June. The caterpillar is about ½ inch in length when full grown, yellowish green, with yellow head, and horny shield on the next segment a little darker, with a black dot on each side. On each of the remaining segments there are some pale, shiny, raised dots (tubercles) from every one of which arises usually a single hair.

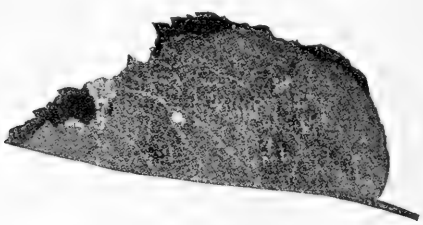

Fig. 22. (From Me. Ag. Exp. Sta. Bul. 177).

In the perfect state this insect is a small white moth with brown markings with an expanse of wings of about ¾ inch.

REMEDIES.

When the injury to the tree is serious the fallen leaves may be raked up and burned in the autumn to restrict the development of the moth the following season.

5. The Cigar Case-Bearer.

(*Coleophora fletcherella.*)

The caterpillars infest mainly the leaves, but in the spring they may also be found on the buds and the young fruits. The full grown caterpillar is reddish orange and averages 1-5 of an inch in length. The case, as it is made in the fall, is a minute flattened curved structure composed of portions of the upper and lower skins of the leaf. In the spring a second case (fig. 23) is made, which is longer, cylindrical or cigar-shaped, in which the larva pupates. The adult insect which emerges from the pupa during June and July is a small, steel gray moth expanding less than ½ an inch.

Fig. 23. (After Slingerland).

Remedies.

This insect can be kept in check by arsenical sprays (Formula 3), the first to be applied as soon as the cases are noticed on the opening buds. A second and perhaps a third application may be necessary at intervals of 4 to 7 days on badly infested trees.

AAA. INSECTS ON OR IN THE FRUIT.

(Divisions a, b, and c.)

a. *Caterpillars with 3 pairs of thoracic and several abdominal legs.*

1. Full grown caterpillar less than ½ inch long, with an anal fork*, mining in the fruit.
   1. *Lesser apple worm.* Page 46.
2. Full grown caterpillar nearly ¾ inch long without an anal fork, mining in the fruit. (fig. 40).
   2. *Codling Moth.* Page 47.

Full-grown mottled caterpillar, 1½ inches long eating into the fruit. *Mottled fruit caterpillar.* Page 24.

b. *Legless maggots or grubs.*

3. Very small slender white maggots mining in the flesh of the apple leaving brownish tracks.
   3. *Apple maggot or railroad worm.* Page 49.
4. A small white grub mining in the very small wind falls in early summer (fig. 25). 4. *Plum curculio.* Page 51.

c. *Mature insects with wings and legs.*

4. A gnarled blackish snout beetle with dusky reddish markings, puncturing the fruit. (fig. 27).
   4. *Plum curculio.* Page 51.
5. A flat yellowish mottled bug with slender beak; ovipositing in and deforming the fruit. (fig. 28).
   5. *Tarnished plant bug.* Page 53.
6. A long legged yellowish brown beetle feeding on fruit. (fig. 18). *Rose chafer.* Page 38.

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*The anal fork can only be seen with a high power microscope, the larva being slightly compressed between cover glass and slide.

1. Lesser Apple Worm.

(Enarmonia prunivora.)

The larva feeds upon the apple in a manner similar to that of the codling moth, for which it is doubtless frequently mistaken. Besides by its smaller size the larva may be distinguished from that of the codling moth by the presence of the anal fork. The adult moth expands about ⅝ of an inch across the wing. The ground color of the front wings is black, with patches of pale rusty red, of gray, and of yellowish white and steel blue oblique lines. The hind wings are dusky gray at the base, shading to black at the apex.

REMEDIES.

The insect may be combated by spraying used against the codling moth.

2. The Codling Moth.

(*Carpocapsa pomonella* L.)

The codling moth passes the winter in the larval stage in silken cocoons in cracks and holes in the trees and in houses where apples have been stored. In the spring these larvæ change to pupæ, and the moths emerge about a month after the apple is in blossom.

The moth (fig. 40, *a*) varies somewhat in size, but the maximum spread of its wings is about three-fourths of an inch. The front wings are of a brownish gray color and are crossed with lines of gray scales, giving them the appearance of watered silk. At the tips of the wings there is a large brown spot, in which are many scales of bronze or gold. The hind wings are grayish brown in color. The moth lays her eggs, a few days after emergence, on the leaves of apple or other food plant, or on the fruit. A majority of the eggs of the first generation are laid on the leaves, while the greater part of those of the second generation are laid upon the fruit.

A large number of the larvæ which hatch from eggs deposited on the leaves eat small portions of the leaves before finding fruit. The larva, living most of its life within the fruit, throws out through its entrance hole, which it enlarges from time to time, or through its exit hole in the side of the fruit, the characteristic mass of frass or excrement which is the sign of infestation.

The larvæ have some difficulty in entering the smooth sides of the fruit, and about 80 per cent of the first generation enter by way of the calyx, while the majority of the second generation enter at the sides, especially where the fruits are touching.

Before entering the young apple the larva feeds, as noted, on the leaves, but also for a day or two within the partial concealment formed by the calyx or blossom end of the apple. During several days, therefore, the little apple worms feed externally, both before they enter the calyx and within the latter, and the object of spraying is to insure their being poi-

soned by thoroughly coating in advance, with an arsenical mixture, the leaves, and especially the blossom end of every fruit, before the shutting up of the lobes of the calyx. Most of the larvæ enter the calyx after it is closed, and are then beyond the reach of any poison later applied.

The pinkish larva lives in the fruit about twenty days, and grows to a length of about five-eighths of an inch (fig. 40) when, being full fed, it makes a tunnel to the outside of the fruit, the entrance of which is filled with frass and silk. When ready to leave the apple this plug is pushed out. The larva then crawls out and immediately seeks a place in which to spin its cocoon.

Cocoons have been observed in the following places: In holes and cracks in the trunks and branches of the trees; under rough bark; in the fruits (though rarely); in the cracks in the ground around the tree; on or between the clods among the fallen fruit; under bands or anything else resting on or against the tree; in cracks and angles of the walls and roof of the building in which apples are stored; under shingles of buildings near apple trees; in fence posts and under pickets of nearby fences; in paper or other rubbish on the ground; and in various other places. The cocoons of the first generation are composed entirely of silk, while in those of the second generation are incorporated bits of wood and bark. The larvæ inside the cocoons transform into pupæ in about six days from the time of spinning the cocoon.

In about twenty days from the spinning of the cocoon the pupal skin splits and the moth emerges (fig. 40, *a*), lays its eggs, and gives rise to another generation.

MEASURES USED AGAINST THE CODLING MOTH.

An arsenical spray (Formula 3) immediately after the blossoms have fallen should be used and repeated 7 to 10 days later. Use burlap bands on trunks, killing all insects under them every 10 days from July 1 to August 15, and once later before winter.

3. Apple Maggot or Railroad Worm.

(*Rhagoletis pomonella.*)

The adult stage of the apple maggot is a fly, a little smaller than the house-fly and readily distinguished by four dark irregular bands across the wings; these are found in the apple orchards from about July first until frost. During this time the females are employed laying eggs, by piercing the skin of the apple with a sting-like ovipositor and leaving at each incision one egg buried in the pulp. Each female is capable of laying at least three or four hundred eggs.

From these eggs hatch apple maggots which tunnel through the pulp where they feed until full grown. The maggots are small, plump, white objects without legs and with head so ill defined that it is difficult to find it at all. The mouth parts are reduced to a pair of rasping hooks. The apple maggot works in soft discolored mushy trails anywhere in the pulp. The trails of the apple maggot never contain little round sawdust-like pellets. Often their tunnels lie directly beneath the skin of the apple, showing through in the light colored varieties as dark trailing tracks which have won for the apple maggot the popular name of Railroad Worm (fig. 44). *But, though the maggot frequently comes near the surface of the apple, it never breaks through the skin until it is through feeding and is thus always protected, a circumstance which shows clearly that it is of no use to try to destroy this pest by spraying.*

When the eggs are laid, the apples are young and hard and for some time the maggots grow very slowly. At this stage the tunnels are very inconspicuous and the maggots themselves are not likely to be detected except by careful search. As the apple matures, the maggot makes more and more headway and is frequently full grown by the time the apple is ripe (fig. 43). Moreover the presence of the maggots seem to hasten the development of the apples and much of the infested fruit comes to the ground as windfalls. *This is the reason so much stress is laid on the destruction of windfalls to get rid of the maggot.*

Since the flies are so long on the wing and lay their eggs over such an extended time, the full grown maggots are found at different periods. The first eggs are laid naturally in the early fruit and accordingly as soon as August tenth full grown

maggots have been recorded in Early Harvests. On the other hand, some of the later maggots, from eggs laid in harder winter varieties, do not acquire their full size until late in the fall or winter. These are the maggots that are stored with the fruit.

The full grown maggots bore out of the windfalls and bury themselves an inch or less in the ground. Or, if they are in gathered fruit where they cannot find a suitable burying ground, they creep away beneath some protecting object instead. Soon after leaving the apple (sometimes the transformation takes place within the apple but not often) the maggots shrink a little in length and bulge a little in thickness, the skin at the same time growing tougher and slightly darker. The insect is known in this form as the pupa, and rests in this stage all winter. With the return of summer a second transformation takes place when the tough skin which has covered the pupa all winter is broken open by the adult insect (a fly with dark bands on its wings) which has developed inside the pupal case. This mature fly spends its life laying eggs in the flesh of young apples, thus starting a new generation of apple maggots.

The maggot, pupa, and adult fly are shown in the accompanying illustration, enlarged about 3 times. (Fig. 24).

Maggot. Fly. Pupa.

FIG. 24.

The apple maggot enlarged 3 times.

PREVENTATIVE MEASURES.

As pointed out here, it is useless to try to poison the growing maggots as they are within and protected by the apple. It is also evident that if the maggots contained in windfalls and picked fruit are destroyed one year there will be no trouble to fear from them the next. Of course it is highly improbable that even by the greatest vigilance, every maggot could be thus destroyed. But when it is considered that each maggot left to its own devices has a chance of becoming a fly capable of lay-

ing at least three hundred eggs, and that each maggot undestroyed this year may mean three or four hundred next year, the importance of killing as many as possible is evident. If the apple maggots, as do many insects, all developed about the same time, the problem would be much simpler, but as full grown maggots are found in apples from before the middle of August until into the winter, the watch for them must extend over several months.

If enough hogs or sheep to eat the windfalls are kept under infested trees from the second week in August until the fruit is finally gathered, all the maggots in windfalls will be got rid of. Of course the same results, as far as destroying the maggot is concerned, can be obtained by having windfalls faithfully gathered during this time and fed to stock, or made into cider.

In one orchard where the main crop is not sweet fruit, a plan of baiting for the apple maggot has proven successful. A few Tolman sweet trees are grown in the orchard as traps. The flies deposit the majority of eggs in these sweet apples by preference, and the other fruit is saved to a great extent. All of the Tolman sweet apples, in this case, are gathered and destroyed.

4. Plum Curculio.

(*Conotrachelus nenuphar.*)

At about the time in early spring when vegetation resumes activity and buds begin to push, curculios, which have hibernated under rubbish on the ground, under the rough bark of trees and in other secure hiding places, emerge from concealment and seek the fruit plants upon which they feed and breed. About the time the trees bloom, mating begins and as soon as the young fruit enlarges the deposition of eggs begins. Apples no larger than small peas often bear from 1 to 3 of the characteristic crescent marks made by the curculio. These punctures as well as those made by the adult beetle in feeding cause a serious deformation of the fruit (fig. 45). The deposition of eggs goes on most rapidly during the month of June, but continues through July and August, gradually growing less and less as the beetles die. The majority of the beetles of this generation do not live beyond the month of July, but a few may survive until September, or in rare instances until late fall.

During the season both males and females feed upon the same fruits in which eggs are deposited, making small, usually cylindrical punctures. The eggs hatch in from 4 to 6 days and the young larvæ start tortuous burrows through the fruit. Development of the larvæ causes the fruit to fall within a few days. In about 20 days the larvæ mature, cease feeding, bore out of the fruit, and at once enter the ground where they complete their transformations and in about 28 days emerge as perfect beetles. (Figs. 25, 26, 27). The newly emerged beetles usually remain quiet for a day or two, allowing the body wall, beak and jaws to harden; then they fly into the trees and begin feeding upon the fruit. Beetles of this new generation do not (except possibly in rare cases) pair and no eggs are laid during this first season. The fruit is freely punctured for feeding purposes and the amount of this work increases as the season advances. It is this feeding of the new generation that causes the greatest injury to the fruit crop. (See fig. 45). Feeding continues as long as fruit remains upon the trees. Late in the fall the beetles leave the trees and hide away in secure places for the long winter period of hibernation. Such in brief is the life history of the plum curculio.

Another curculio known as the *Apple curculio* is smoother and has a longer snout. This species has not been recorded from Maine.

REMEDIAL MEASURES.

Destruction of fallen fruit is one of the chief means of combating this pest. Where hogs are pastured in the orchard with a view to devouring apple maggots in fallen fruit the curculios would be incidentally disposed of. The recommendations that fallen fruit be destroyed commonly conveys no idea of the first fallen apples. The mind turns to the tangible fruits of midsummer and fall, and where the recommendation is followed the small apples that fall in early summer are entirely ignored. The same small apples are, however, an important factor, and should be considered in any systematic attempt to control the ravages of the plum curculio.

Fig. 25. Larva (enlarged). Fig. 27. Adult (enlarged).
Fig. 26. Pupa (enlarged).

It does not seem possible for an apple one-fourth inch or less in diameter to supply nourishment enough to bring a larva to full maturity, but it has been learned that larvæ can and do develop in just such apples. To gather them would be impracticable, but if clean culture is practiced they and the larvæ they contain could be largely destroyed by use of the disk harrow or some other tool that would chop them up or bury them. If the ground is clean and the orchard sufficiently open, so that the sun can shine upon the apples as they lie upon the ground, nothing further is necessary, because direct sunlight upon the apples will kill the contained larvæ. Superficial tillage of the surface soil can be commended as an effective method of attacking curculio. This tillage should be carried on continuously or at frequent intervals for a period of from 30 to 40 days, during which the great bulk of the new crop of plum curculios is in the ground. The object of tillage is to turn the pupæ out, kill some in the process, and expose the rest to the elements and to birds and insects that prey upon them.

5. Tarnished Plant-Bug.

(*Lygus pratensis.*)

This insect is a very destructive one, and injuriously affects a large number of cultivated plants. It passes the winter in the perfect state, taking shelter among rubbish, or in other convenient hiding-places, and early in May, as soon as vegetation starts, it begins its depredations.

These insects are partial to the unopened buds, piercing them from the outside and sucking them nearly dry, which causes them to become withered and blackened. Sometimes a whole branch will be thus affected, being first stunted, then withering and finally dying. This insect also causes serious deformation of

the fruit both by feeding and egg-laying punctures. Early in the morning these plant-bugs are in a sluggish condition, and may be found hidden in the expanding leaves; but as the day advances and the temperature rises, they become active, and when approached dodge quickly about from place to place, drop to the ground, or else take wing and fly away. In common with most true bugs, they have when handled a disagreeable odor. In the course of two or three weeks they disappear, or cease to be sufficiently injurious to attract attention.

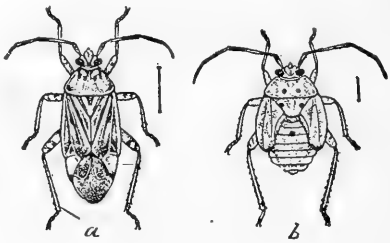

FIG. 28. (After Chittenden). Enlarged.

The mature bug (fig. 28, *a*) is about one-fifth of an inch long, and exceedingly variable in color and markings, ranging from a dull brown to a greenish or yellowish-brown. In a typical specimen the head is yellowish, with three narrow reddish stripes; the beak is about one-third the length of the body, and is folded upon the breast when not in use. The prothorax has a yellow margin and several longitudinal yellowish lines; behind the prothorax, upon the scutellum, is a yellow V-shaped mark; the wings are dusky brown, with a pale cuneus and black point at the apex; the legs are dull yellow. The immature insects are greenish; if a little older they possess a pair of round black dots on the back of the thorax, another pair on the scutellum, and a single dot on the abdomen.

COMBATATIVE MEASURES.

Since these insects hibernate among rubbish of all kinds, clean culture is very important. By clean culture is understood the removal of all litter from fence corners, so as to take away the shelters in which the insect winters. When they appear in spring the plants upon which they are should be shaken early in the morning, while the bugs are still in a torpid condition, making them fall upon a sheet underneath, and then destroying

them. As soon as it becomes warm the insects are exceedingly active, and so swift in all their motions that they cannot be captured.

BENEFICIAL INSECTS.

(Adapted from Packard.)

In a great variety of ways certain insects are helpful to man, and are especially efficacious either in insuring his crops or in destroying those insects which would otherwise devour them.

Pollenizers of Fruit-trees.—A very important part in the production of abundant crops of fruit is played by bees and other honey- or nectar-gatherers, and pollen-feeding insects. It is now generally acknowledged that bees, especially the honey-bee, act as "marriage-priests" in the fertilization of flowers, conveying pollen from flower to flower, and thus insuring the "setting" of the fruit. Many wasps, as well as butterflies and moths, species of pollen-eating beetles, thrips, and other insects, by unconsciously bearing pollen from distant flowers, prevent too close in-and-in breeding. Indeed, as Goethe said, flowers and insects were made for each other. Many plants would not bear seeds did not insects fertilize them. Insects are in the first place attracted to flowers by their sweet scent and bright colors, and it is claimed that the lines and circles on the corolla of certain flowers guide them to the nectary; though we do not see why the scent is not in the main sufficient for this purpose. According to Sir John Lubbock, "The visits of insects are of great importance to plants in transferring the pollen from the stamens to the pistil. In many plants the stamens and pistil are situated in separate flowers: and even in those cases where they are contained in the same flower, self-fertilization is often rendered difficult or impossible; sometimes by the relative position of the stamens and pistil, sometimes by their not coming to maturity at the same time. Under these circumstances the transference of the pollen from the stamens to the pistil is effected in various ways. In some species the pollen is carried by the action of the wind; in some few cases, by birds; but in the majority, this important object is secured by the visits of insects, and the whole organization of such flowers is adapted to this purpose."

Parasitic Insects (Ichneumons and Tachinæ).—While insectivorous birds accomplish much towards reducing the numbers of injurious insects, they often as likely as not eat the beneficial as well as the destructive kinds. Without doubt the leading factor in preventing the undue increase of noxious insects are the parasitic kinds belonging to certain dipterous and hymenopterous families.

An ichneumon-fly (figs. 46-49) lays its eggs either on the outside of the caterpillar or bores under its skin inserting an egg within the body. The larva of the ichneumon upon hatching works its way into the interior of the host. Here it does not injure the muscles, nerves, or the vital parts of the caterpillar, but apparently simply lies motionless in the body-cavity, absorbing the blood of its host.

Tachina (Exorista) militaris has been observed by Riley to lay from one to six eggs on the skin of the army-worm, "fastening them by an insoluble cement on the upper surface of the two or three first rings of the body." The young maggots on hatching penetrate within the body of the caterpillar, and, lying among the internal organs, absorb the blood of their host, causing it finally to weaken and die. Sometimes but a single maggot lives in its host. Many grasshoppers as well as caterpillars are destroyed by them.

Insectivorous Insects.—There are very many carnivorous kinds which devour insects entire. Such are the ground-beetles (fig. 51), water-beetles, the larvæ of Tenebrionids and of lady-beetles (Coccinella) (figs. 52, 53), and those of the lace-winged flies (Chrysopa) which prey on Aphids, though the maggots of the Syrphus flies are more abundant and efficacious as Aphis-destroyers.

Practical Application.—When the life of an injurious insect is carefully studied, it is frequently found that the pest can be combated by breeding and distributing its natural parasitic and predaceous enemies. For a most remarkable example of such an undertaking it is only necessary to mention the work of the U. S. Government and Massachusetts against the Gypsy Moth. For current accounts of this work the reader is referred to the Annual Reports of the Mass. State Forester, and publications of the U. S. Bureau of Entomology.

GENERAL TREATMENT FOR APPLE ORCHARDS.

While the enemies of the apple are numerous and varied, by far the larger part of them may readily be held in check by spraying with the more common insecticides and fungicides, and often, by a combination of materials, several enemies may be met with one application. There should, however, be a definite purpose in view for every application. The mere fact of spraying is not enough. It is important that the orchardist know *why* and *how*, and *when* to spray or otherwise combat his enemies. Beneficial insects should be recognized when seen, and should be protected and encouraged. Certain diseases may be controlled by spraying; in other cases diseased parts must be removed and burned.

The time of spraying will depend upon the purpose in view, but in *no case* should spraying be done when the plants are in full bloom. Spraying at this time will often interfere with the fertilization of the flowers, and consequently reduce the crop of fruit, while there is much needless destruction of bees and other insects which work upon the flowers.

Insecticides and fungicides are more effective if applied in a liquid rather than in a dry form, since they adhere to the foliage better. *Sprinkling is not spraying.* The best results are obtained from the use of a fine spray or mist forcibly applied to the foliage; and so far as possible, it should reach the under side of the leaves. A fine mist is preferable to a coarse spray, as there is much less waste of material and much less danger of injury to the foliage. A single dash of the mist is better than continued soaking, as in the latter case the material gathers in drops and runs off or injures the foliage.

The treatment of apple trees at various times during the season and the purpose of the same may be briefly stated as follows:

A. Lime-Sulphur wash (Formula 7), before buds begin to swell. For oyster shell bark louse or San José scale.

B. Tanglefoot, smear on bands of tarred paper about the trees early in spring. For canker worm.

C. Bordeaux mixture and Paris green or lead arsenate .

(Formula 8 or 9), as soon as the buds open, before blossoming. For apple scab, leaf blight, rot; and for bud moth, canker worm, tent caterpillar and forest caterpillar.

D. Bordeaux mixture and Paris green or lead arsenate (Formula 8 or 9), as soon as the blossoms have fallen. For scab, leaf blight, rot, canker worm, tent caterpillar and codling moth.

E. Repeat D after about two weeks. Omit E if experience in your locality warrants it.

F. Bordeaux mixture (Formula 1), two weeks after the last treatment and still again if the season is very wet. For scab, leaf blight and rot.

The tent caterpillar, forest caterpillar and canker worm must be met *early,* (just as soon as they appear), in order that spraying shall be effective.

Kerosene emulsion (Formula 4) applied in June, when the eggs first hatch, is an effective treatment for oyster shell bark lice. It is also destructive to plant lice when these appear.

In place of the lime wash, treatment with caustic soda (Formula 5) may be used for oyster shell bark louse.

Culture.

If the *curculio* and the *apple maggot* are present practice clean cultivation, plowing about three times during the season, beginning in June if the curculio is present or in July if only the maggot is troublesome; the last plowing to be made after the fruit is gathered.

Gathering Windfalls.

As both the larva of the curculio and of the maggot are found in the small apples and later leave these to pupate in the earth, it is highly important to rake up frequently all windfalls and destroy them. This means not only the larger apples but even those which are no larger than a pea. Where sheep or hogs are pastured in an orchard the trouble of gathering windfalls by hand is avoided.

Fungous Enemies.

Fungi can be successfully combated only before the plants are attacked.. The more important fungous diseases of the

apple in Maine which may be controlled wholly or in part by spraying are: scab; black, brown, pink, and bitter, rot; fly-speck and sooty blotch of the fruit, leaf spot, and various forms of limb canker.

Apple scab is one of the most troublesome of the fungous diseases in Maine. This is so well known as not to require description. Bordeaux mixture (Formula 1) is the best general preventive of fungous attack. For apple scab, spray with Bordeaux mixture (Formula 1) before the buds open; repeat as soon as the blossoms fall, and again two or three times during the season.

Materials Used in Fighting Apple Enemies.

CAUTION: *The following formulas are for use on the apple. In many cases they are not adapted for more tender plants. Keep all poisons carefully labelled and out of the reach of children and animals.*

Formula for apple scab and other fungous diseases.

Formula 1. Bordeaux mixture.

Copper Sulphate	3 pounds
Fresh Lime (unslaked)	3 pounds
Water	50 gallons

How to prepare Bordeaux mixture.

(To be used the same day as made.)

The copper sulphate is dissolved and the lime slaked in separate vessels. A wooden or earthen vessel must be used for the copper sulphate, as it corrodes iron. Each solution should then be diluted with half the water and then the cold, *dilute sulphate and milk of lime solution quickly united and thoroughly mixed.* Never pour concentrated solutions together. If unpracticable to pour the two dilute solutions into the sprayer or mixing tank simultaneously, the dilute copper sulphate solution should be first placed in the tank and the dilute milk of lime solution quickly added with constant stirring.

Best results are obtained if care is taken to add the water slowly to the lime while slaking, but it should not be allowed to become dry. The milk of lime must be strained and this is

best done while still hot. A brass wire strainer of about 30 meshes to the inch (No. 50) or a piece of cheesecloth backed by common window screen may be used. The best type of strainer can be made by nailing together four one-inch boards about 7 or 8 inches wide and 12 or 15 inches long making a box open at both ends. One end of the box is then cut off at a considerable angle leaving one side shorter than the other. No. 50 brass wire strainer is tacked on to this end. Two cleats are nailed to the other end of the box long enough to more than reach across the top of a barrel. When placed on top of a barrel with the wire bottom down all the solid particles from the solution are washed to the lower side of the screen, thus avoiding clogging the whole surface.

HOW TO PREPARE BORDEAUX MIXTURE.

(Stock solutions which may be kept indefinitely.)

The most convenient method of preparing Bordeaux mixture is to make stock solutions. For this purpose suspend 50 pounds of copper sulphate in a bag near the top of a 50-gallon barrel and fill with water. This should dissolve over night. In another 50-gallon barrel slake 50 pounds of stone lime, dilute and strain and make up to 50 gallons. A gallon of each solution *well stirred* with be equivalent to 1 pound of copper sulphate or lime as the case may be. For a 50-gallon tank of mixture the stock solutions should be thoroughly stirred and then 3 gallons of each dipped out, diluted and mixed as described above.

Although the solutions will keep while separate, they should not be combined until the day they are to be used.

Air-slaked lime should never be used in making Bordeaux Mixture.

FORMULAS FOR INSECTS WHICH CHEW.

Formula 2. PARIS GREEN.

Paris Green .....½ pound
Lime (unslaked) .....3 pounds
Water .....50 gallons*

The standard remedy for the destruction of insects which eat the foliage or fruit. The lime is added to prevent the Paris green from burning the foliage. Slake the lime in a little water.

make into a thin paste and strain. Wet the Paris green with a little water and make into a thin paste. Mix the lime and Paris green and add the remainder of the water.

Formula 3. LEAD ARSENATE.

Lead Arsenate or Disparene .....2 pounds
Water .....50 gallons*

Arsenate of lead acts slower as a poison than Paris green. It has the advantage, however, of remaining longer in suspension in water, of not burning the foliage and of adhering better than Paris green. Make a smooth thin paste with the poison and a little water and add the remainder of the water and stir thoroughly. In our own practice this is preferred to Formula 2. It is excellent for canker worm on elm trees.

FORMULAS FOR INSECTS WHICH SUCK.

Formula 4. KEROSENE EMULSION.

Hard Soap .....½ pound
Boiling Water .....1 gallon
Kerosene .....2 gallons

To prepare, dissolve one-half pound of soap in one gallon of soft water by boiling; when well dissolved and still boiling hot, remove from the fire and add two gallons of kerosene, and agitate at once as briskly as possible. The emulsion is more readily made if the kerosene first be heated by immersing the vessel containing it in a larger vessel of boiling water. *Never* heat the kerosene over a direct fire.

If large quantities are being made, a good way to emulsify is to use a force pump and spraying nozzle and pump the mixture as forcefully as possible back into the vessel containing it. If the emulsion is properly formed, the whole mass will appear much like whipped cream and will mix readily in water without a film of oil rising to the top.

As soon as emulsified, add twenty-seven gallons of water and use at once. This will make thirty gallons of the mixture, and such an emulsion will be one-fifteenth oil (or a 7% emulsion).

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*An ordinary oil barrel holds about 50 gallons. This amount is sufficient for 15 to 25 trees.

This is the strength ordinarily used for the destruction of insects upon plants. For larger or smaller quantities, prepare in the same proportions.

Sometimes the emulsion is not perfect and a little oil rises to the top. In such cases, if the last in the barrel or tank is pumped out upon the foliage, it is likely to burn it. So it is advisable, unless the emulsion is of good quality, to throw out the last few gallons, making no use of it.

It is best to dilute and apply kerosene emulsion as soon as it is prepared.

Avoid using alkali or any hard water in making the emulsion, as it will cause the oil to separate and rise to the top. Any clean, soft water will usually give good results.

Formula 5. MISCIBLE OILS.

There are several miscible oils upon the market which may be added directly to water forming a milky emulsion at once. In the preparation of any of these, such as "Scalecide," or "Target Brand Scale Destroyer" or "Killoscale," add the oil directly to the water with a little stirring. One gallon of the miscible oil in 30 to 50 gallons of water will make a mixture, which in most cases will be strong enough to kill plant lice, if thoroughly applied.

Formula 6. WHALE-OIL OR FISH-OIL SOAPS.

The so-called whale-oil or fish-oil soaps which are quite extensively used for the destruction of plant lice, will usually be effective if thoroughly applied in the proportion of one pound of the soap to each six or eight gallons of water. There are numerous brands of these soaps upon the market. Among those that have been used quite successfully are Good's Whale-Oil Soap and Bowker's Tree Soap.

Formula 7. SOAP SOLUTION.

Washing Powder .....½ pound
Water .....3 gallons

The soap dissolves readily in the water.

Formula 8. TOBACCO DECOCTION.

Tobacco stems or tobacco dust.....2 pounds
Water .....4 gallons

Put the tobacco in the water, enough to cover, which may be either cold or hot. Place over the fire and when the water has reached the boiling point, remove some of the fire and allow the water to simply *simmer* for fully one hour, when the liquid is ready to be drained off, diluted to the above proportions and applied. Boiling violently drives off the nicotine.

If whole-leaf tobacco is used, prepare as above, using one pound of tobacco to each four gallons of water.

No lime or other alkaline substance should be added to the tobacco while cooking. Apply at once, or within a few days after making if possible.

Black Leaf.—There is nothing to do in the preparation of Black Leaf except to thoroughly stir the contents of the can before pouring out any quantity for dilution. In most cases one gallon of the Black Leaf will be found sufficient for each seventy gallons of water. But if in the treatment of any louse this does not seem sufficient it may be used in proportion of one gallon to sixty or sixty-five gallons of water. Careful sprayers have usually succeeded in killing plant lice with this preparation in the proportion of one gallon to each one hundred gallons of water. Thoroughness of application is of as much importance as the strength of the material used.

Formula 9. CAUSTIC SODA.

Caustic Soda .....1 ounce
Water .....2 gallons

The soda dissolves readily and may be used in any amount desired. It is a strong caustic, however, and must be used with care, and only when the trees are dormant.

Formula 10. LIME, SULPHUR WASH.

(For winter spray only.)

Flowers of Sulphur.....15 pounds
Good Lump Lime.....15 pounds
Water .....45 gallons

This is the 1 1-3 lime-sulphur mixture. First slake the lump lime with sufficient warm water, and while still boiling hot add the sulphur and stir it in. Place over fire and continue the boiling, adding water when necessary, until the mixture changes

to a deep reddish brown color which indicates that the lime has cut the sulphur. It will be necessary to boil steadily for about forty minutes to one hour to produce this result. The mixture should then be diluted to form forty-five gallons of the spray, and should be applied at once.

When the lime-sulphur mixture is placed in the barrel or tank it should be strained to take out all lumps that would clog the spray nozzle. If allowed to stand for any great length of time after being prepared, the lime-sulphur crystalizes out to a considerable extent. In such a case it is necessary to heat the mixture again before applying so as to dissolve all the crystals. If the crystals are re-dissolved the mixture will be as strong as before.

Commercial Lime-Sulphur Washes.

There are a number of commercial brands of concentrated preparations of lime-sulphur on the market. Some of these are excellent and of uniform composition, others are wholly unreliable.

FORMULAS FOR COMBINED INSECTICIDES AND FUNGICIDES.

Make a smooth paste of the poisons and a little water, add to the Bordeaux mixture and stir thoroughly. Apply at once.

Formula 11.

Paris Green .....½ pound
Bordeaux Mixture .....50 gallons*

Formula 12.

Lead Arsenate or Disparene.....1 pound
Bordeaux Mixture .....50 gallons*

How to Spray.

Spraying is an effective method of securing perfect fruit and healthy foliage. To obtain the best results, insecticides and fungicides must be applied forcibly in the form of a fine mist, *not* in coarse drops lightly sprinkled over the foliage. Inas-

*An ordinary oil barrel holds about 50 gallons. This amount is sufficient for 15 to 25 trees.

much as spraying is a preventive measure (not a cure) the whole surface of the tree must be covered. In large orchards three men can usually work to advantage,—one to drive the team and work the pump, the others to handle the nozzles.

THE APPARATUS.

The necessary apparatus consists of a force pump, with two lines of hose, nozzles, a barrel or tank for holding the spraying mixture, and a wagon for carrying all.

The Pump: The pump should be large enough to easily supply two lines of discharge hose and to develop a pressure of at least 60 pounds to the square inch. It should also have a good agitator. The small bucket pumps and knapsack sprayers do very well for a few trees in the garden, but for field work they are unsatisfactory. All parts of the pump that are subject to wear should be made of brass and should be carefully adjusted. The pump and all other apparatus should be thoroughly washed every time after using.

The Hose: Two pieces of ½-inch hose or better, of ⅜-inch double insertion hose, fifty feet long, are needed, if the operators are to stand on the ground. In case a raised platform is built above the wagon, twenty-five feet of hose in each line will be sufficient. For very tall trees a bamboo extension rod is preferred to an extra long piece of hose.

The Nozzle: There are many good nozzles, but the best tried at the Experiment Station, is the Vermorel, sold by most dealers in spraying apparatus. The Vermorel throws a finer spray than the others, but is easily clogged unless the spraying mixture is carefully strained through cheese-cloth or a fine wire screen before using.

The Barrel: A kerosene barrel, holding about fifty gallons, is a convenient tank. A small opening should be made in which to place the pump, and another, larger one, through which to fill the tank and stir the mixture.

The Wagon: Any low wagon, or even a dump-cart will answer the purpose. For convenience in turning, a two-wheeled cart is to be preferred. For tall trees, if not planted too close together, a high platform built over the hind end of the wagon, on which the operators may stand, will be found useful.

REFERENCES TO LITERATURE ON APPLE INSECTS.

a. CIRCULARS AND BULLETINS FROM THE MAINE AGRICULTURAL EXPERIMENT STATION.*

Circular. Red-Humped Caterpillar.
" Yellow-edge or Mourning Cloak Butterfly.
" Yellow-neck Caterpillar.
" Cecropia Moth.
" Tent Caterpillar.
" Forest Tent Caterpillar.
" Tussock Moth.
" Brown-Tail Moth.
" Apple Maggot or Railroad Worm.
" Plum Curculio.
" Tiger Swallow-tail Butterfly.
" Sphinx Chersis and other Hawk Moths.
" Fall Web Worm.
" Tiger Moths.
" Bud Moths.
" Io Moth.
" Two Scale Insects of Maine.
Bulletin 161. Saddled Prominent.

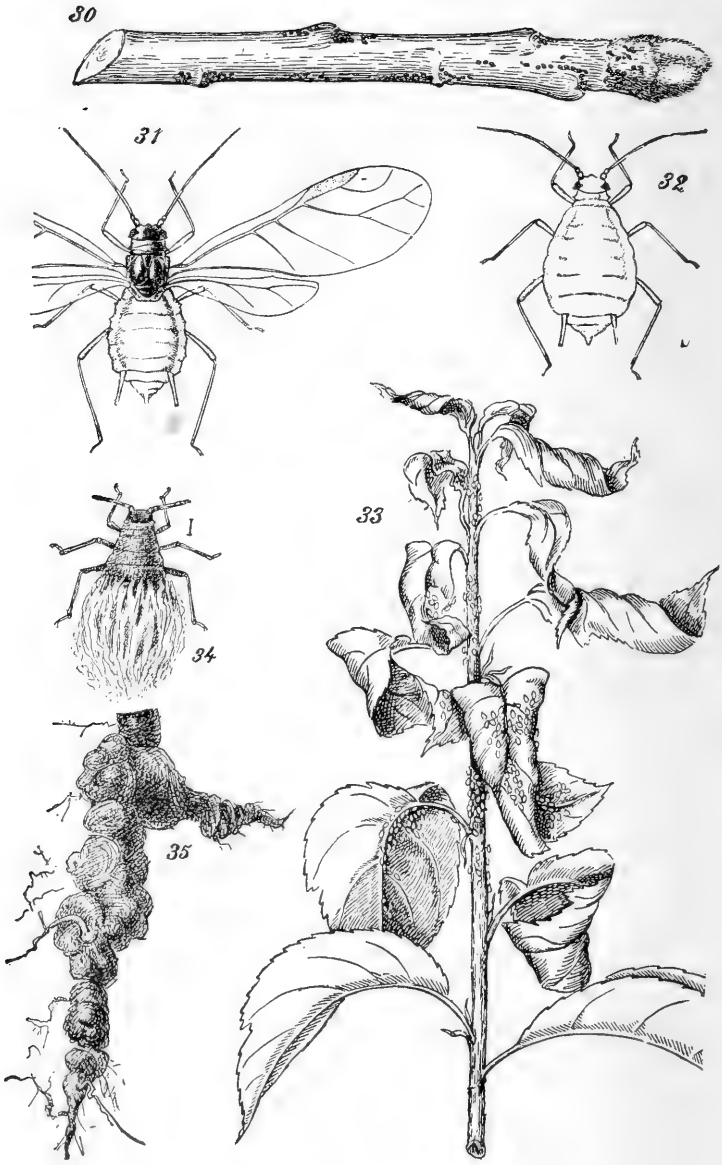
b. CIRCULARS AND BULLETINS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.**

Circular	7.	Bureau of	Entomology.		Pear-tree Psylla.
"	9.	"	"	"	Canker Worms.
"	11.	"	"	"	Rose Chafer.
"	20.	"	"	"	Woolly Aphis of the Apple.
"	26.	"	"	"	Pear Slug.
"	29.	"	"	"	Fruit-tree Bark-beetle.
"	32.	"	"	"	Larger Apple-tree Borers.

*These may be secured free of charge by applying to "Maine Agricultural Experiment Station, Orono, Maine."

**These may be secured free of charge by applying to the U. S. Department of Agriculture, Washington, D. C.

Circular	42.	Bureau of Entomology.	How to Control the San Jose Scale.
"	81.	" " "	Aphids Affecting the Apple.
"	98.	" " "	Apple-tree Tent Caterpillar.
Farmers' Bulletin	127.	Bu. of Ent.	Important Insecticides.
" "	264.	" " "	Brown-tail Moth and How to Control It.
" "	275.	" " "	Gypsy Moth and How to Control It.



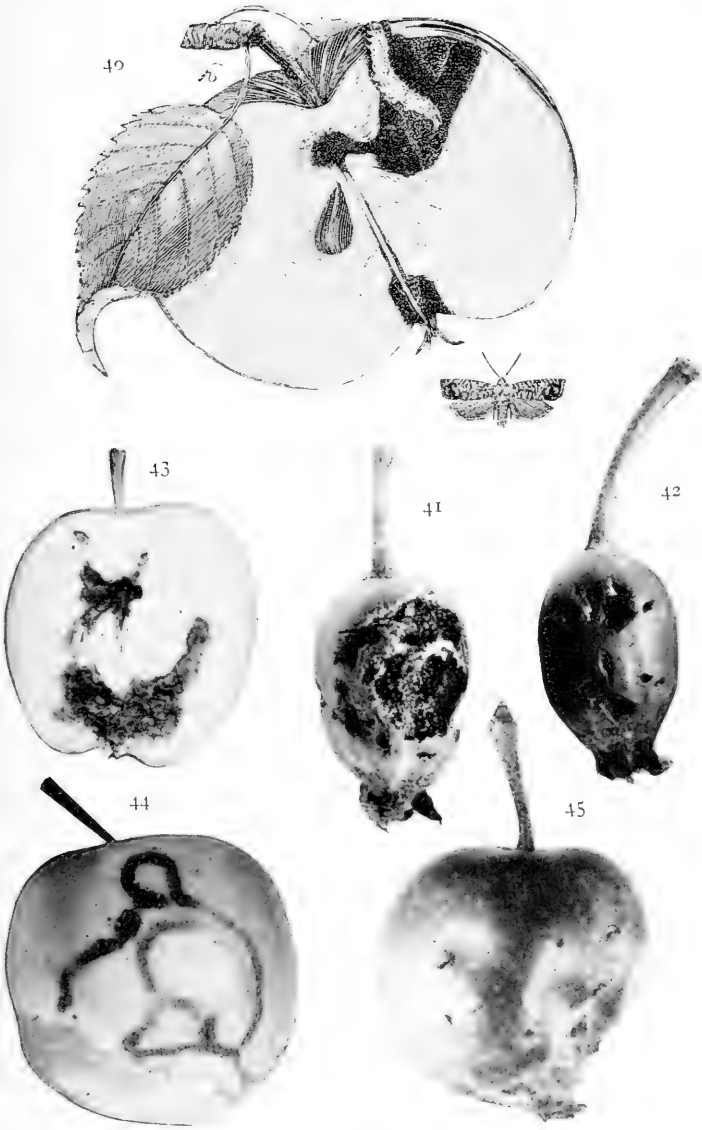
APPLE APHIDS AND WORK.

FIGS. 30-33 Green apple-aphis; 30, Winter eggs; 31, Winged form; 32, Wingless form; 33, Leaf curl caused by Apple-aphis; 34, Woolly aphis, wingless form; 35, Knotty root caused by Woolly aphis.

(FIGS. 30-33 after Quaintance; 34, 35 after Marlatt).

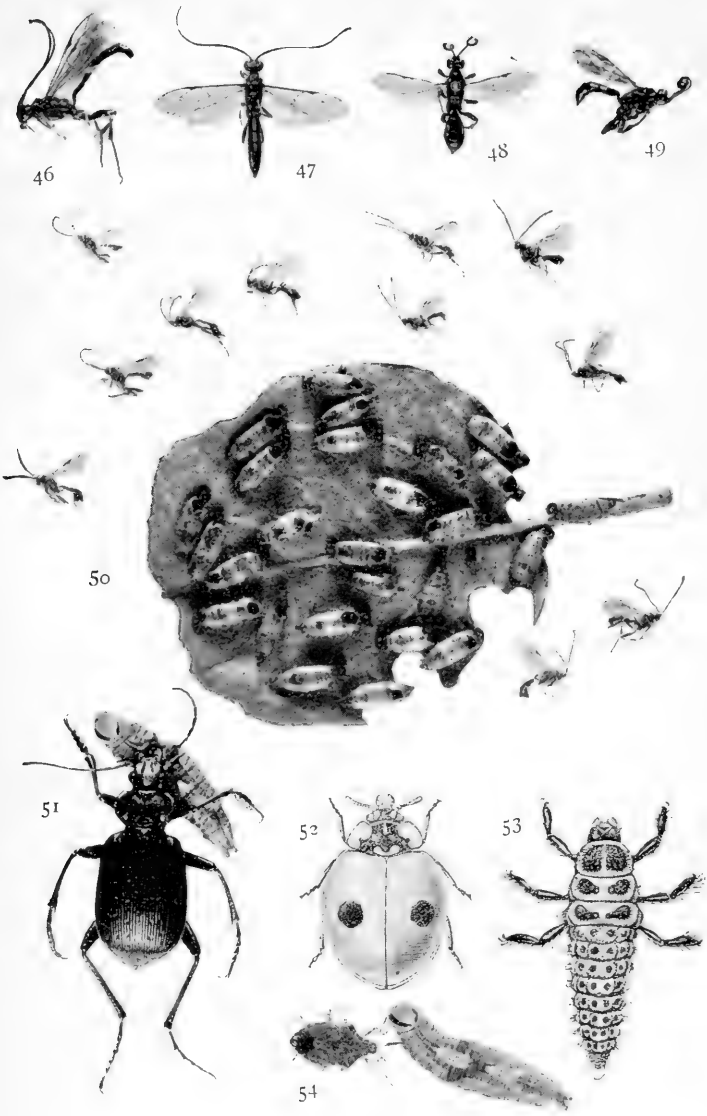
WINTER STAGES

Photographed from Maine specimens. Fig. 36, Eggs from which Tent Caterpillars hatch. Fig. 37, Cocoon of Cecropia Moth. Fig. 38, Winter nest of Brown-tail Moth. Fig. 39, Eggs of the antique Tussock Moth on cocoon.



APPLES INJURED BY INSECTS

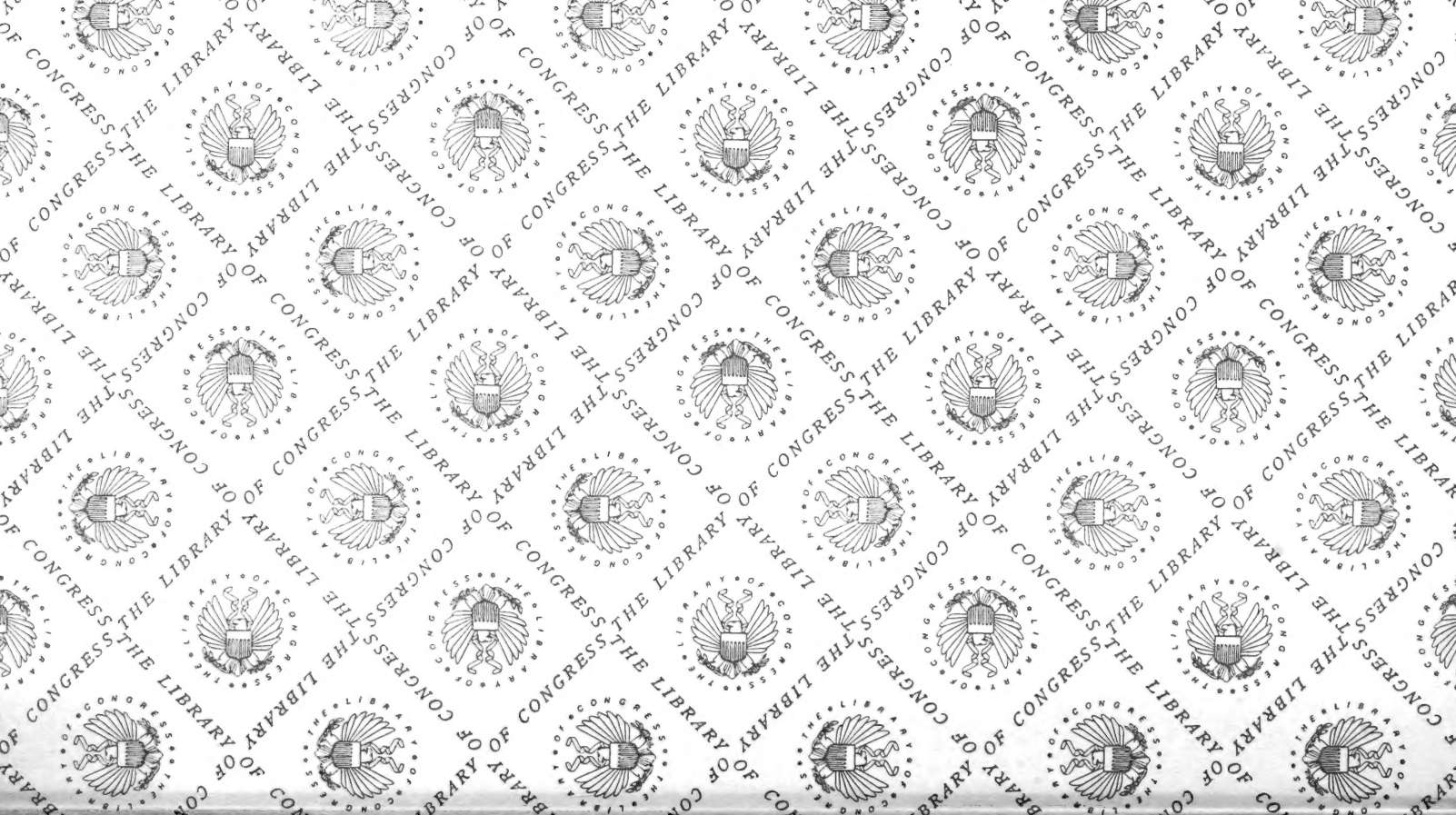
Fig. 40, Coddling Moth *(after Lodeman)*. Figs. 41, 42, Apples eaten by Rose Chafer (photographed July, 1907). Fig. 43, Section of apple showing work of apple maggot (Photographed Oct., 1907). Fig. 44, Hightop with characteristic trail of apple maggot (Photographed Sept., 1903). Fig. 45, apple deformed by apple curculio (Photographed July 11, 1907).



BENEFICIAL INSECTS

Figs. 46-49, Ichneumon sublatus, parasites bred from pupae of Saddled Prominent. Fig. 50, Parasitized specimens of young Red-humped Caterpillars attached to apple leaf and parasites *(Limneria guigardi)* which emerged from them. Photographed August 29, 1906. Fig. 51, Beetle *(Calosoma)*, feeding on Saddled Prominent (Bul. 161 Maine Agr. Exp. Sta.) Fig. 52, 53, Lady Beetles, adult and larva, which feed on Aphids *(After Marlatt.)* Fig. 54, Podisus modestus, a bug stabbing the Saddled Prominent (From Bul. 161 Maine Agr. Exp. Sta.)

Fig. 55. Mottled Fruit Caterpillar *(Crocigrapha Normani)*. Photographed July 10, 1907.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