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ENTOMOLOGICAL SERIES, No. 20.

The Brown-Tail Moth.

FIG. 1. Female Brown-Tail Moth. Natural size.

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THE BROWN-TAIL MOTH

Euproctis chrysorrhoea Linn.

By W. E. Britton, *State Entomologist.*

The brown-tail moth was found in Thompson in 1910 and is now present throughout the northeastern portion of Connecticut, about one-third of the area of the state being infested. Though the pest has not as yet become sufficiently abundant generally to cause noticeable injury, it is spreading gradually and will soon infest the entire state. During each of the last three years, scouts employed by the writer have cut off and destroyed the winter nests. Had this not been done considerable damage would doubtless have resulted in Thompson, Putnam, Pomfret and Woodstock, where the nests were thickest.

Several articles relating to the insect have appeared in the reports and bulletins of this Station during the past few years, but they are now inadequate and the purpose of this bulletin is to give a brief account of the brown-tail moth, its distribution and spread up to the present time, and to point out the best methods of control. The illustrations will enable one to recognize the insect in its different stages.

Status of the Moth Abroad.

The brown-tail moth is a native of the Old World where it is found from Algiers on the South to Sweden on the North and from England on the West to the Himalaya Mountains on the East. Over most of this area it is recognized as a pest of orchards and forests. At more or less regular intervals there are outbreaks of this insect, resulting in severe damage and often the trees are stripped on large areas.

Dr. L. O. Howard,* in 1909, found this insect present in in-

*Bureau of Entomology, Bull. 87, p. 21, 1910.

jurious numbers in certain parts of Europe, especially in France. The same year Mr. H. L. Frost* of Arlington, Mass., found that the Thiergarten in Berlin had been closed to the public on account of the serious poisoning of people by hairs from the caterpillars, which were very abundant.

APPEARANCE AND DISTRIBUTION IN AMERICA.

From the best information obtainable it appears that the brown-tail moth was accidentally introduced into this country on nursery stock at Somerville, Mass., more than twenty years ago. It was first brought to the attention of entomologists in 1897, when it was identified as the brown-tail moth, and a special bulletin was at once issued by the Massachusetts Agricultural Experiment Station giving information about the insect. About a dozen towns were then known to be infested and the Massachusetts legislature passed a law requiring local authorities to suppress the brown-tail moths. This law is still in force. In 1898, $10,000 was made available for the control of this insect, and the work was placed under the Board of Agriculture.

By this time the insect had already become firmly established and soon spread to adjacent territory. In December 1899, the first nest was found in New Hampshire at Seabrook; in the spring of 1904 many pear trees at Kittery, Me., were found to be infested; during the fall of 1906, the brown-tail moth was reported at Pawtucket, East Providence and Woonsocket in Rhode Island. On April 6th, 1910, winter nests were received at this office from Mr. Richard Barton of Thompson, Conn., who stated that they were found by men employed by Mr. H. L. Frost in pruning trees in that locality. This is the first record of the establishment of the insect in Connecticut, and was published in the report of this Station for 1910, page 683. In August 1911 the first brown-tail moths were found in Vermont at Guilford.

Meantime the brown-tail moth had been spreading westward in Massachusetts to the Connecticut River Valley, and a separate infestation had been discovered in North Adams.

*Ibid.

At the present writing, February, 1914, the brown-tail moth has spread over the following territory: the southern part of Maine and about 3000 square miles of Nova Scotia, and 6000 square miles in New Brunswick; the whole of New Hampshire except possibly a few of the northern-most towns of the state, in upper Coos county; the western half of Vermont, except possibly a few towns in Essex and Orleans counties along the northern border; nearly all of Massachusetts, except a part of Berkshire county, and possibly a few adjoining towns; the whole of Rhode Island; about one-third of Connecticut including Windham and Tolland counties and a portion of Hartford and New London counties; and this winter, nests have been found on Fishers Island, which belongs to the State of New York.

From the foregoing paragraphs it will be seen that the pest has spread much more rapidly and now extends farther toward the north and east than toward the south and west. Though the climatic conditions may be slightly more favorable in that direction, the chief reason is probably due to the prevailing winds, which in summer blow northeastward.

DISCOVERY AND SPREAD IN CONNECTICUT.

For a period covering several years, occasional reports appeared in the newspapers, or in correspondence regarding the presence of brown-tail moths in certain places in the state. These reports were investigated by this department, and as a rule it proved that some other common insect had been mistaken for the brown-tail moth, and the reports were therefore incorrect. But on April 6th, 1910, the following letter was received from Mr. Richard Barton of Thompson, manager of the large place of Mr. Norman B. Ream:

Dear Sir:—I am mailing to you under separate cover in a box some caterpillars' nests found near the highway on a pear tree by one of Mr. H. L. Frost's men, who was doing some pruning in this village. He thought it was the brown-tail, and so I took them and carefully cyanided them and sent them to you for identification. I really hope that they are not brown-tails, as we have not yet been troubled with them in this section. However, if you find that they are, if you will kindly let me know at once I will see what I can do to have a search made in the village with a view to stamping them out.

It proved to be the brown-tail moth, and two assistants, Messrs. Walden and Champlain, visited Thompson and hunted for nests and found in all about a dozen. On May 10th of that year they sprayed with lead arsenate all trees from which the nests were cut.

FIG. 2. Pear tree at Putnam stripped by brown-tail caterpillars. (Photo. June 15, 1910.)

In June, caterpillars were found in Putnam by Mr. John H. Osgood and submitted to Professor G. H. Lamson, Jr., of the Agricultural College, Storrs, who sent them to this office. Mr. Walden visited Putnam and Mr. Osgood showed him the trees, some of which were nearly defoliated. (See figure 2).

The following winter, Federal scouts, who were looking for gypsy moth eggs, reported that brown-tail nests were

rather abundant on fruit trees in the yards of Putnam and that they observed them also in Thompson and Pomfret.

Consequently early in 1911, a gang of men under Mr. Donald J. Caffrey, scouted that section of the state for the purpose of destroying the nests and learning the extent of the infestation. Five towns were found infested. A total of 7,133 nests being destroyed, 112 in Thompson, 937 in Woodstock, 5,989 in Putnam, 89 in Pomfret and 6 in Killingly.

In this work only the open country was examined, and the nests removed from orchard and roadside trees and from the borders of the woodland within reach. To examine the whole forest area and to remove nests from the tall oaks would require a sum of money greatly in excess of our appropriation, and was therefore impracticable.

In September 1911 a colored placard 11 x 14 inches in size and giving illustrations of the brown-tail moth and information regarding it, was issued as a special bulletin of the Station. A copy was sent to each library, grange hall, post office and railroad station in Connecticut, and to all schools desiring it.

The following winter 1911-1912, the territory was again searched and a total of 3,084 nests were found in nine towns as follows: Thompson, 966; Woodstock, 699; Putnam, 1,260, (against 5,989 the previous year); Pomfret, 82; Killingly, 27; Brooklyn, 35; Sterling, 1; Plainfield, 13; and Stafford, 1. In May, 1912, caterpillars were found in Norwich by Mr. J. E. Fanning. Mr. Caffrey visited the place and found that only a comparatively small area between two streets seemed to be infested, and had all the trees in that area sprayed with poison.

In 1912-13, a nest was received from West Hartford, and the scouts examined many towns beside those previously known to be infested. A total of 29 towns were found infested and 7,592 nests were destroyed. On account of the infestation the Federal Horticultural Board established, August 1st, 1913, a quarantine. No nursery stock can be shipped out of the infested area which has not first been examined before being packed, and certified by a Federal inspector. This quarantine will probably be extended from time to time, to correspond with the territory infested by the brown-tail moth.

The location of these towns and the quarantine line are shown by the shaded area on the map in figure 3.

At the present writing the scouts are at work and they have found nests in Granby, Columbia, Lebanon, Colchester, Ledyard, Groton, New London, Waterford, East Lyme, Old Lyme and Saybrook. Other towns not shaded on the map will probably be found infested. Nests have recently been found on Fishers Island.

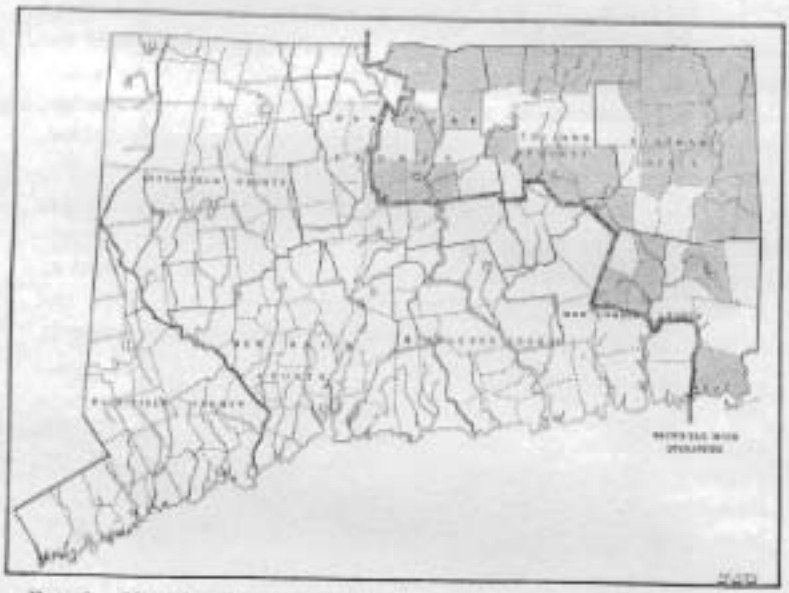

FIG. 3. Map showing quarantine line and distribution of brown-tail moth in Connecticut in 1913.

INJURY TO VEGETATION.

The brown-tail caterpillars injure trees by devouring their leaves. When caterpillars are abundant trees are often stripped, thus weakening them and causing considerable injury. At present in Connecticut, outside of the fruit trees, little injury has been done, but in Massachusetts and New Hampshire the infestation is greater and much injury has resulted. In Europe, also, repeated attacks have either killed the forest trees or greatly reduced their vitality so that they are often

attacked and killed by borers. Many fruit trees in Eastern Massachusetts have been killed by the caterpillars.

Food Plants.

Fernald and Kirkland gave a list* of about eighty species of trees and plants on which the caterpillars are known to feed. The pear is the first preference of the caterpillars, followed by the apple and the stone fruits. Oaks, maples and elms are perhaps the chief kinds of shade and forest trees liable to be injured. As the gypsy caterpillars feed upon over six hundred different kinds of plants, it will be seen that the brown-tail is much more limited in regard to its food plants. Pear, apple and oak trees are stripped by the brown-tail caterpillars.

Conifers are not attacked but the caterpillars will feed upon most of the deciduous trees as well as many shurbs, vines and herbs, if their favorite food is lacking.

Danger to Health.

The hairs of the caterpillars are barbed and brittle, and break off easily. When they come in contact with the human skin, they cause an irritation or rash which is quite serious with certain persons. The worst forms of rash are caused by actual contact with the caterpillars, but the broken hairs which blow about will cause the milder forms. The matter has been carefully studied by Dr. E. E. Tyzzer** of the Harvard Medical School, who finds in these hairs a definite poisonous principle which causes certain changes in the blood. The long hairs do not seem to possess this quality, but the short barbed hairs of the red dorsal tubercles are the ones chiefly responsible, though similar hairs occur with the long ones on various portions of the caterpillar, and on the posterior extremity of the body of the adult. In making the cocoon the hairs are rubbed from the caterpillar and woven into the new structure, and those from the adult female are worked into the formation of the egg-mass, so that either cocoon or egg-mass may produce the rash. Such hairs are doubtless cast

*The Brown-Tail Moth, Mass. Board of Agriculture, p. 57. 1903.

**Second Annual Report of the Superintendent for Suppressing the Gypsy and Brown-Tail Moths, p. 154. 1907.

with the skin when the caterpillars molt, and are often rubbed or broken off from their bodies and blown about, and coming in contact with the skin of human beings cause the brown-tail rash.

FIG. 4. Brown-tail moths on tree and electric light pole, Lowell, Mass., 1910. (After Burgess, Bureau of Entomology, U. S. Dept. of Agriculture.)

As a remedy for this rash Kirkland recommends the following, which should be well shaken together and rubbed thoroughly upon the affected parts:

Carbolic acid	½ drachm
Zink oxide	½ ounce
Lime water	8 ounces

MEANS OF SPREAD.

It is chiefly in the adult stages that the brown-tail moth spreads to infest new territory. The moths emerge during the first half of July and both sexes fly and are attracted to lights. They may often be seen during the day at rest on electric light and trolley poles in infested towns and cities, as shown in figure 4. A gale at this time, carries large numbers of moths with it and if blowing towards uninfested territory, the pest will spread several miles in a season. Moths are also attracted by the lights in vehicles, railway coaches and trolley cars and are often carried long distances, and no doubt new infestations are started in this manner. Thus from July 4th to July 18th, 1912, when the moths were flying, Mr. D. M. Rogers, who was then in charge of the Federal work in Massachusetts, stationed two men at Putnam, Conn., to examine all trains headed westward or southward, to remove the adult brown-tail moths, and 75 moths in trains and around the station were destroyed.

Caterpillars in their winter nests may be transported on nursery stock, or in the waste often used as packing material, in an infested region. In fact the first nests found in Connecticut came on fruit tree seedlings imported in 1909 from a French nursery. From this stock 52 nests containing living caterpillars were taken, and the following year 14 more nests were found. Had it not been for this inspection the pest might have become established around these nurseries, one of which was in the southwest corner of the state, and some of the stock might have been shipped elsewhere, perhaps to other states.

The young caterpillars, like gypsy caterpillars, canker worms and many other larvæ, spin down upon cars and vehicles or any object passing beneath the trees and may thus be carried. Nearly full grown caterpillars, especially in a badly infested center, often strip their trees and crawl about for food. If they crawl upon a trolley car or other vehicle they might easily be carried some distance.

It is certain, however, that most of the spread is due to the flight of the moths.

LIFE HISTORY AND HABITS.

The partially grown, though yet small caterpillars pass the winter in silken webs or nests at the ends of the twigs. These nests are composed of leaves and silk, are from two to four inches long, and are shown in figures 5, and 6. They first occur on pear, apple and wild cherry trees, and if very abundant in the locality attack also oaks and most other deciduous trees. There are no other nests that need be mistaken for

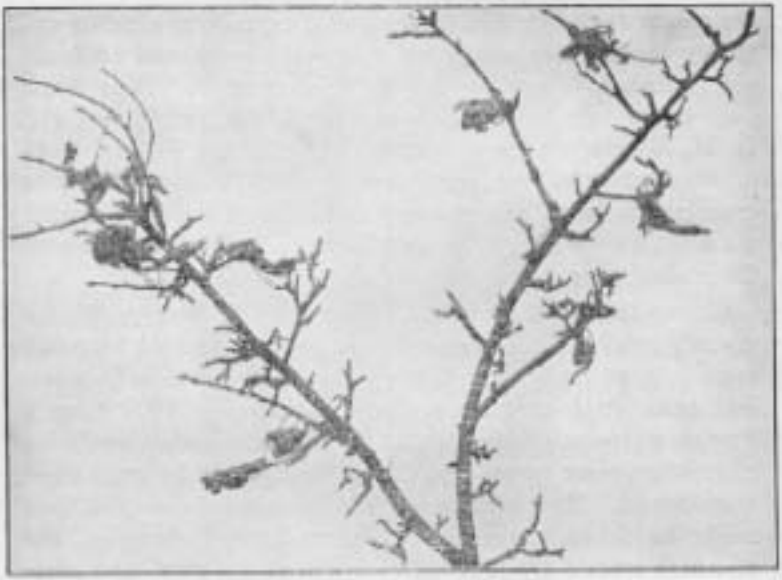

FIG. 5. Winter nests on pear tree.

these, though many Promethea cocoons (see figure 7) are sent to this office with the idea that it is the nest of the brown-tail moth.

On the approach of the warm days in April the caterpillars emerge and begin to feed upon the opening buds. They molt three, and sometimes four times, becoming full grown about the middle of June, when they are from one and one-fourth to one and one-half inches long, and appear as in figure 8. Each then draws together a few leaves, fastening them with silk threads, and pupates within them. It is common to find

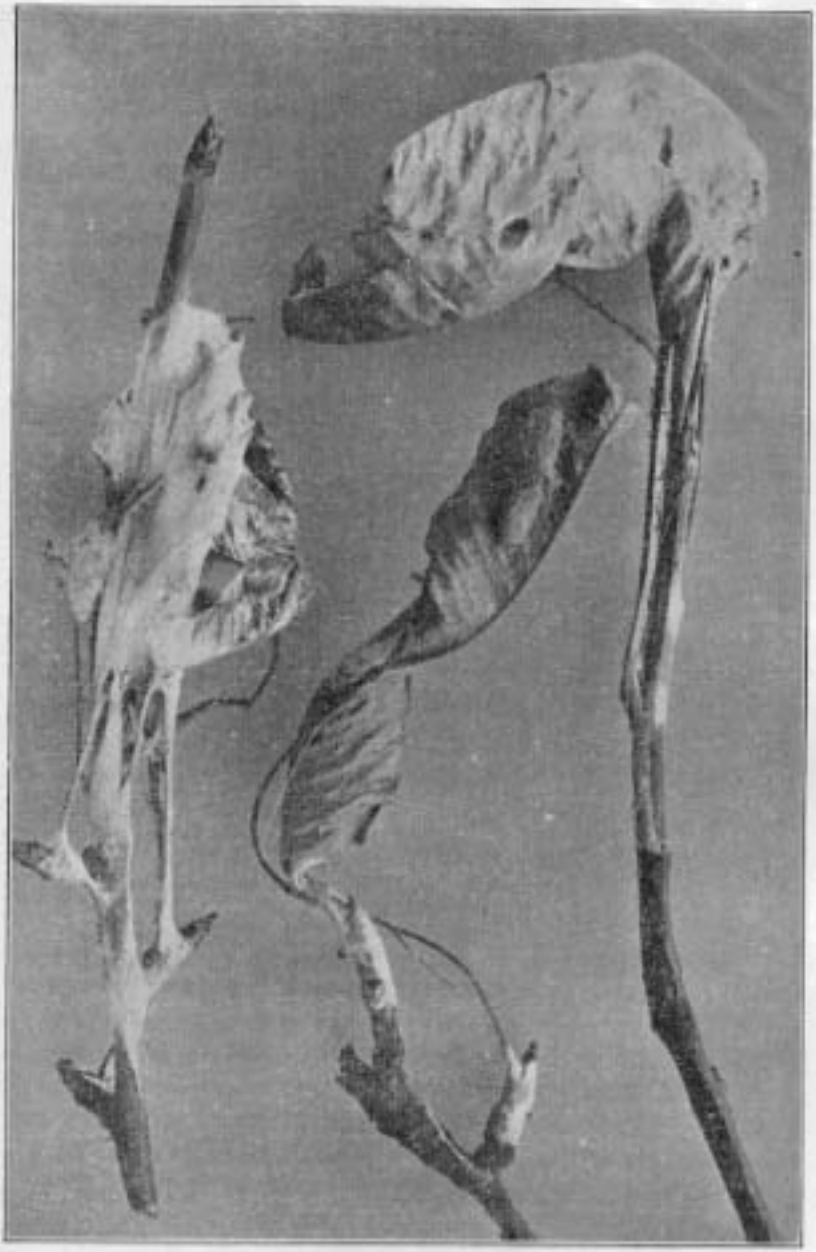

FIG. 6. Winter nests cut from a pear tree in Hartford; center nest shows old egg-mass on leaf. Natural size.

three, four or more pupæ in a bunch of leaves. When abundant the caterpillars will also transform under fence rails rubbish and other protected places.

The cocoon stage lasts from fifteen to twenty days and then the moths appear, usually during the first half of July. As a rule they emerge late in the afternoon and are ready to fly the first night. Both sexes fly and are strongly attracted by lights. Figure 4 shows the moths at rest on an electric light

FIG. 7. Cocoon of Promethea moth. Natural size.

pole in Malden, Mass. The moths begin at once to lay eggs which are usually found in elongated reddish-brown masses containing from 200 to 400 eggs each, on the underside of a leaf and shown in figure 9. The white females may often be seen with folded wings laying the eggs as in figure 10. The egg-masses vary greatly in size and shape but are usually from half to three-fourths of an inch long and perhaps one-fourth of an inch broad.

Nearly three weeks later, or about the first of August, the eggs hatch and the young caterpillars at first feed on the surface of the leaf bearing the egg-cluster causing it to turn brown as if scorched. Later they go to other leaves for food and when five days old they molt. Early in September they begin to make the web or nest in which they are to spend the winter. This is made by drawing together some old leaves, usually including that bearing the old egg-mass, which sometimes shows on the outside as in figure 6. These leaves are fastened to the twig by encasing their petioles with woven silk which is woven also around the twig so that it cannot be torn away. Much silk is used in the construction of the nest which is usually at or near the end of the season's growth. The nests vary greatly, however, in size and shape depending upon their location and the materials available. Probably all caterpillars hatching from the same egg-mass usually go into the same winter nest, but where the insect is abundant and there are five egg-clusters on a single leaf as the writer saw in New Hampshire, it seems as if they must get somewhat mixed. Possibly in such cases several colonies unite in the nest, and this may account for the unusually large nests occasionally found. The caterpillars feed for a time, after making the nest, going into it when not feeding, but on the approach of cold weather they crowd into it one hundred or more in a nest and close the opening, remaining there until spring.

DESCRIPTION.

Egg. The eggs are spherical, yellow in color and are laid on the under surface of a leaf in elongated clusters from half to three-fourths of an inch long, and about one-fourth of an inch thick. Such an egg cluster contains from 200 to 400 eggs which are covered with the reddish-brown hairs from the body of the moth. Egg-masses are shown in figure 9. Eggs are deposited during the first half of July and hatch in about three weeks or early in August.

Caterpillar. The fully grown caterpillar is reddish-brown in color, the body being dark brown splashed with light brown and bearing light brown hairs. Beginning with the fourth segment each segment bears a pair of white tufts,

one on each side. These show both dorsally and laterally, and from above appear as two broken white stripes. They disappear, however, in rubbed specimens, the white hairs breaking off readily. On each of the ninth and tenth segments there is a small coral red tubercle bearing poisonous hairs. Length

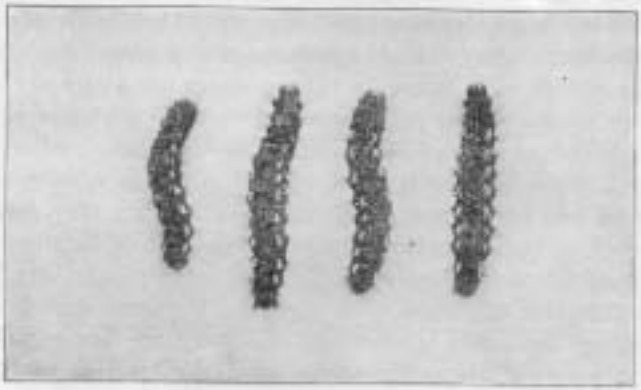

FIG. 8. Brown-tail caterpillars. Natural size.

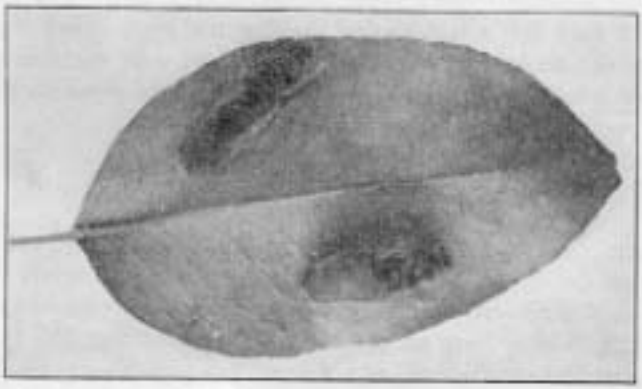

FIG. 9. Egg-mass on leaf. Natural size.

one and one-quarter to one and one-half inches. The caterpillar stage lasts from August, when the eggs hatch, until the larva becomes full grown about the middle of the following June. During this time it molts three, and sometimes four, times. The caterpillars are shown in figure 8.

Winter Nest. The nest is constructed by the caterpillars when they are about one-fourth of an inch long, usually in the month of September. One or more terminal leaves are folded and fastened to the end of the twig with gray silk which also forms the greater part of the tissue of the nest. It is very strong and cannot readily be torn. The old egg-mass often shows on the outside of the nest. Though usually from two to four inches long the nests vary greatly in size and shape, and are frequently reduced to almost nothing, or are somewhat larger than the size given above, probably due to several colo-

FIG. 10. Female laying eggs, slightly enlarged.

FIG. 11. Cocoons of brown-tail moths. Natural size.

nies uniting in the same nest. Nests are shown in figures 5 and 6.

Cocoon. The pupæ are generally clustered together in folded leaves and fastened with loose silk, as shown in figure 11. The naked pupa is about half an inch long, and less than half as broad, tapering abruptly toward the tail. Color, dark brown. This stage lasts from fifteen to twenty days, depending somewhat upon the weather conditions.

Moth. The adult is pure white with the end of the abdomen covered with reddish-brown hairs. In the male there

is a brown suffusion along the front margin of the underside of the forewings and the antennæ are more or less tinged with brown. In size there is a variation from an inch to an inch and a half in wing-expanse, the females being larger than the males and having thicker bodies. The males on the other hand have larger antennæ. The females are often seen with folded wings laying eggs as in figure 10. Both sexes are shown in figure 12. The moths fly during the first half of July and are attracted by lights.

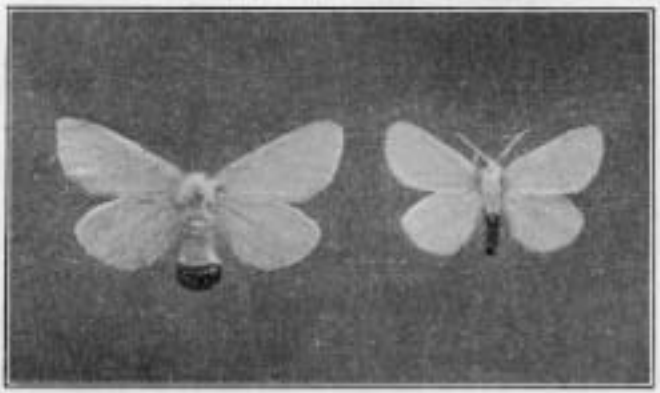

FIG. 12. Brown-tail moths. Natural size. Female at left.

NATIVE PARASITES AND OTHER ENEMIES.

In certain moist seasons a native fungus *Entomophthora (Empusa) aulicae* Reichardt attacks and kills many small caterpillars in the nests and likewise the larger ones in early summer. The latter die on the trees or stones of buildings and walls and remain there for a time as in figure 13. This disease killed millions of the caterpillars in 1906 in Massachusetts, and occasionally since then it has aided in holding the pest in check. Under favorable conditions it is capable of killing sixty per cent. or more of the caterpillars. In a dry season, however, it kills few caterpillars, and like other fungous diseases of insects, does the most effective work in badly infested centers where the caterpillars are very abundant and are crowded together.

A few native insect parasites normally attacking related species also attack the brown-tail moth but are not important in checking it. Birds, especially the cuckoos, feed upon the caterpillars, and many kinds of birds devour the moths. Even English sparrows were seen by Mr. Kirkland to feed upon them in 1897. But these native enemies working together are not effective in greatly reducing the numbers of the insects.

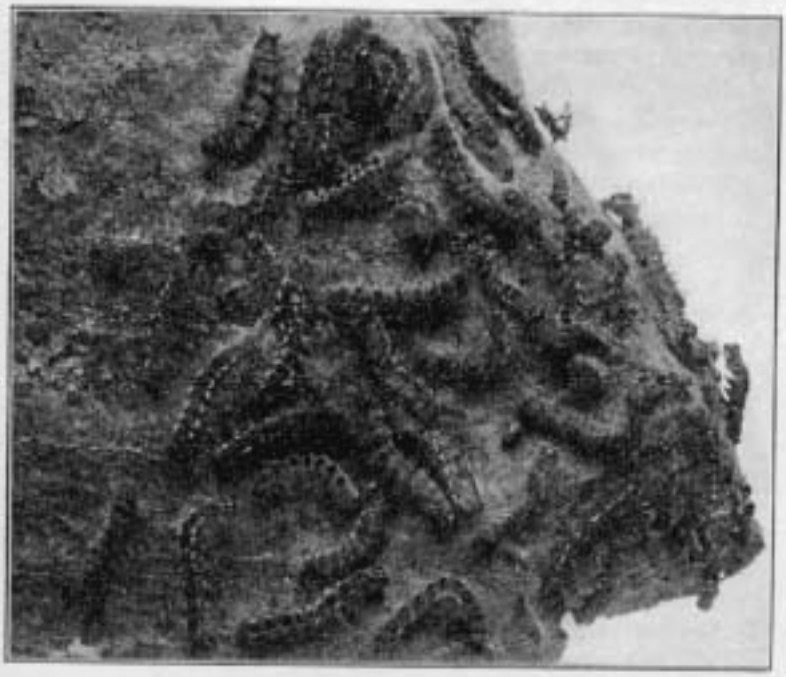

FIG. 13. Brown-tail caterpillars killed by fungous disease.

IMPORTED PARASITES.

Realizing the possibility of obtaining relief through the importation of certain parasites which serve to hold the gypsy and brown-tail moths in check in Europe and other countries where these pests occur, the officials in charge of suppressing these insects in Massachusetts, early sought the cooperation of the Bureau of Entomology at Washington, in seeking parasites abroad and in introducing them into this country.

Consequently, Dr. L. O. Howard, Chief of the Bureau of Entomology, visited Europe in 1905, and enlisted the aid of many entomologists there in collecting and sending material to the laboratory in the infested section of Massachusetts. Either Dr. Howard or an assistant traveled abroad on this work each summer until 1910, and as a result thousands of packages of parasitized material were received from all the countries where the gypsy and brown-tail moths are found. The parasites were reared and studied in captivity and the primary parasites separated from the secondary and hyperparasites. Colonies were afterward liberated.

From the enormous mass of material collected and studied two egg parasites, *Telenomus phalaenarum* Nees., and a species of *Trichogramma* were colonized but seem to be unimportant in controlling the brown-tail moth. From hibernating caterpillars four parasites *Pteromalus egregius* Forst., *Apanteles lacteicolor* Vier., *Meteorus versicolor* Wesm., and *Zygobothria nidicola* Towns., were reared, colonized, and have now become firmly established in this country. The last named species is a dipterous or two-winged fly of the family Tachinidæ, the other three being four-winged flies of the order Hymenoptera. Several Tachinid flies were found to attack the larger caterpillars and one of them *Compsilura concinnata* Meig., is now established and bids fair to be of some value. Some of these parasites have not only withstood the New England winters but have spread a considerable distance from the point where they were liberated.

Several predatory beetles were also introduced, and a large species *Calosoma sycophanta* Linn., promises to be of considerable value.

This large-scale introduction of parasites is the most important experiment ever made, and is watched with interest by entomologists all over the world.

In 1912, Mr. A. F. Burgess who now has charge of the government moth work in New England, planted a colony of *Compsilura concinnata* at Putnam, and in 1913 another colony at Hartford. This species has not yet been recovered in Connecticut. *Apanteles lacteicolor*, one of the most promising of the hymenopterous parasites was also planted in a colony of 1000 individuals at Putnam in 1912 by Mr. Burgess. In

1913 it was recovered from nests collected by Mr. Caffrey in five towns, viz., Thompson, Woodstock, Pomfret, Stafford and Somers, the last named town probably receiving it from some point in Massachusetts where parasites were liberated. In 1913 additional colonies of *A. lacteicolor* were planted in nine places viz., Hartford, Suffield, Mansfield, Hampton, Danielson, Plainfield, Griswold, Norwich and Stonington. This parasite is shown in figure 14.

The parasites mentioned above can do no harm as they

FIG. 14. *Apanteles lacteicolor*, a promising imported parasite which has been brought into Connecticut. (After Howard and Fiske, Bureau of Entomology, U. S. Dept. of Agriculture.)

attack only some form of insect life, and they may prove a real help in the control of the brown-tail moth pest.

CONTROL MEASURES.

As both male and female moths are strong fliers the spread of the species cannot be prevented. An infestation cannot be eradicated as in case of isolated colonies of the gypsy moth. By reducing its numbers to the minimum, however, we greatly lessen the danger of its rapid spread, as well as the amount of damage which it may do by defoliating trees and by afflicting people with brown-tail rash.

As the adults are attracted by lights it has been suggested that by means of trap-lights, large numbers of moths might be destroyed. Several careful tests have been made with such traps and though large numbers of moths were caught, a large proportion of them were males.

Though we must practice control measures on our fruit trees in the orchard and around the home, we must rely chiefly on natural agencies to control it in the large wooded areas. The principal control measures are removing the nests in winter, and spraying the foliage in summer.

REMOVING WINTER NESTS.

After the leaves have fallen the nests are conspicuous at the ends of the twigs as are shown in figures 5 and 6, and by

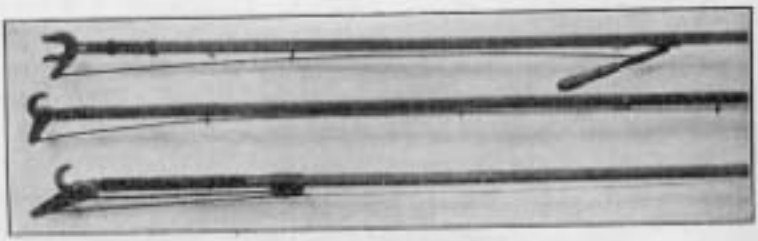

FIG. 15. Tree pruners for clipping off nests.

means of tree pruners can easily be clipped off and burned. There are several forms of tree pruners on the market, three of them being shown in figure 15. Each is mounted on a long pole thus enabling one to reach the nests without climbing. (See figure 16). All orchard trees and all fruit trees around the buildings, as well as all deciduous trees along the highways and around the cultivated fields and borders of the woodlands should be examined during the winter months and the nests removed.

It is not practicable to remove the nests from forests, as they cannot be detected on oak and beech trees which hold their leaves through the winter. Even if they could be seen the nests are out of reach without climbing, and the cost of this is prohibitive.

If the ground is covered with snow, it is easier to find the nests after they have fallen to the ground. A strong paper bag makes a good receptacle in which to carry the nests and on reaching the house the bag and contents should be put

FIG. 16. Workmen cutting off brown-tail nests; this tree in Hartford bore 220 nests.

into the furnace or stove where there is a hot fire. If the nests are allowed to remain in a warm place the caterpillars will emerge and crawl about.

SPRAYING.

It is not easy to control the brown-tail moth by spraying in early summer because the caterpillars often devour the young leaves as fast as they unfold, and there is no leaf-surface to poison. If the foliage is thoroughly sprayed about August 1st, the young caterpillars will be killed as soon as they begin to feed on the leaves. This is perfectly feasible on trees not fruiting; where the fruit has been gathered early; or where it will not be harvested until October, as with winter varieties of apples and pears. One should be careful, however, about spraying the fruit which will ripen a few days later.

The best poison for spraying is lead arsenate, which may be used at the rate of three pounds of the paste form to a barrel. If the dry powder is used, only half as much is needed.

LOCAL OR COMMUNITY EFFORT.

On account of the rash, the brown-tail moth is perhaps a greater pest than on account of its damage to vegetation. As the moths are attracted by lights, they gather in villages and cities, and around the homes in the country. In thickly settled communities it avails little for one resident to practice control measures if his neighbors do not. Community effort is, therefore necessary in order to achieve the best results. Though in every locality there are individuals who will keep their own trees free from pests, there are also others who, unless compelled to, will do nothing about it. State laws in New Hampshire and Massachusetts require that each property owner, before a certain time, remove the winter nests from all trees on his grounds. If he fails to do this, the town or city authorities must do so, and the cost becomes a tax which is collected from the property. In like manner all municipal authorities must remove the nests from all city, or town, property, parks and along the public highways. Likewise if this is not done by a certain fixed date the state authorities may order it done at the expense of that city or town.

LEGISLATION NEEDED IN CONNECTICUT.

Notwithstanding the control work which has already been done in Connecticut by this department, the pest will continue

to spread and will gradually cover the entire state. Nearly one-third is now infested. This scouting and removing of nests cannot be continued over the entire area; the appropri ation is insufficient. Even were it adequate for the purpose, it probably would not be advisable. The owner should give some attention to the care of his own property. Hence, it will probably be necessary in the near future to pass laws similar to those in Massachusetts and New Hampshire requiring cities, towns and individuals to remove the brown-tail nests from the trees and shrubs on the land owned and controlled by them.

SUMMARY.

DISTRIBUTION. The brown-tail moth was probably introduced accidentally on nursery stock at Somerville, Mass., more than twenty years ago; it was brought to the attention of entomologists in 1897. It has long been known as a pest in Europe where it causes much damage to fruit, shade and forest trees. It also occurs in Western Asia and in Northern Africa.

The insect has spread toward the north and east much faster than toward the south and west, probably going in the direction of the prevailing winds. It now covers a part of Nova Scotia; Southern Maine; nearly the whole of New Hampshire; almost the entire eastern half of Vermont; all but the extreme western portion of Massachusetts; all of Rhode Island; and the northeastern portion (about one-third) of Connecticut. It was first discovered in Connecticut in April, 1910; within a few years it will probably extend all over the state.

DAMAGE. The caterpillars feed upon many kinds of trees and injure them, but seem to prefer fruit trees. Oak, maple and elm are next attacked.

The hairs of the caterpillars break off and blow about; on coming in contact with the human skin they cause a rash or irritation accompanied by intense itching, which is very serious with some persons.

LIFE CYCLE. The eggs are laid on the under side of a ea the first half of July, in masses containing from 200 to 400 eggs. They hatch inside of three weeks or early in August and the young caterpillars skeletonize the leaves from the upper side, making their nest in September at the tips of the twigs. They live in this nest through the winter, emerge and feed on the new leaves in the spring, becoming full-grown about the middle of

June. They then transform to pupæ in the folded leaves and from fifteen to twenty days later the moths appear. Both sexes are white with brown hairs at the end of the abdomen; they fly at night and swarm around electric lights. The moths have a wing-expanse varying from one to one and one-half inches.

NATURAL ENEMIES. A fungus in moist seasons kills many caterpillars. Some kinds of birds devour them and many kinds eat the moths. Many parasites have been imported into Massachusetts, from Europe and other countries, and some of them have become established. Colonies of two of the most promising have been brought into Connecticut; one of them has been planted in ten different towns and has been recovered several miles from the point where liberated.

CONTROL MEASURES. Cutting off and burning the nests in winter, and spraying the foliage in August with lead arsenate, are the best methods of control on fruit trees. This cannot be done in the forest.

Community effort, especially in towns and cities, is essential, and probably laws similar to those in force in Massachusetts and New Hampshire requiring property owners, and city and town officials to remove nests from the land under their control, will soon be needed in Connecticut.