CIRCULAR No. 109. Issued July 6, 1909.

United States Department of Agriculture,

BUREAU OF ENTOMOLOGY,

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THE LEOPARD MOTH.

(*Zeuzera pyrina* Fab.)[a]

By L. O. HOWARD and F. H. CHITTENDEN.

INTRODUCTORY.

Deciduous trees of many kinds, grown for shade and for ornament in northern New Jersey and eastern New York, are subject to severe injury by the larval stage of the European leopard moth (*Zeuzera pyrina* Fab.). Among the shade trees, elms and maples suffer the greatest damage, but as this species is a very general feeder it attacks practically all descriptions of trees and shrubs with the exception of the evergreens. In the region mentioned this species is, everything considered, the most serious menace to the growth of shade trees, since, unlike the majority of lepidopterous insects, the larvæ of the leopard moth do not feed upon the foliage, but bore into the branches of the plants which they infest and feed upon the living wood. The larvæ usually begin operations in twigs and small branches and with their larger growth bore and tunnel into the larger branches and trunks. This work has the effect of girdling, the injured portions being blown down by heavy wind storms, while in the case of severe attack the growth of the tree is checked, frequently causing its death. Attack is not confined solely to shade and ornamental plants, but orchards are often injured.

DESCRIPTIVE.

Injury by this species is accomplished solely by the larva, which is a fleshy, grublike caterpillar, pale yellowish in color, frequently with a pinkish tinge. The head, thorax, and anal plates are brownish-black and the surface of the body is very sparsely hairy but covered

[a] Family Cossidæ. Synonyms: *Zeuzera æsculi* L., *Z. decipiens* Kby., etc.

with large and prominent tubercles arranged as shown in the illustration (fig. 1, *c*). When fully mature the larva attains a total length of about 2 inches. A lateral view of the larva in its burrow is shown in figure 1 at *c*.

This species derives its name from the spotted appearance of the moth, illustrated at figure 1, *a*, *b*. There is great diversity in the size of the two sexes, the female (*a*), which is a heavy-bodied moth and a very feeble flyer, being much the larger. It will be noticed that the smaller male (*b*) has a more slender body, which permits a more ready flight, and is also distinguished from the female by the pos-

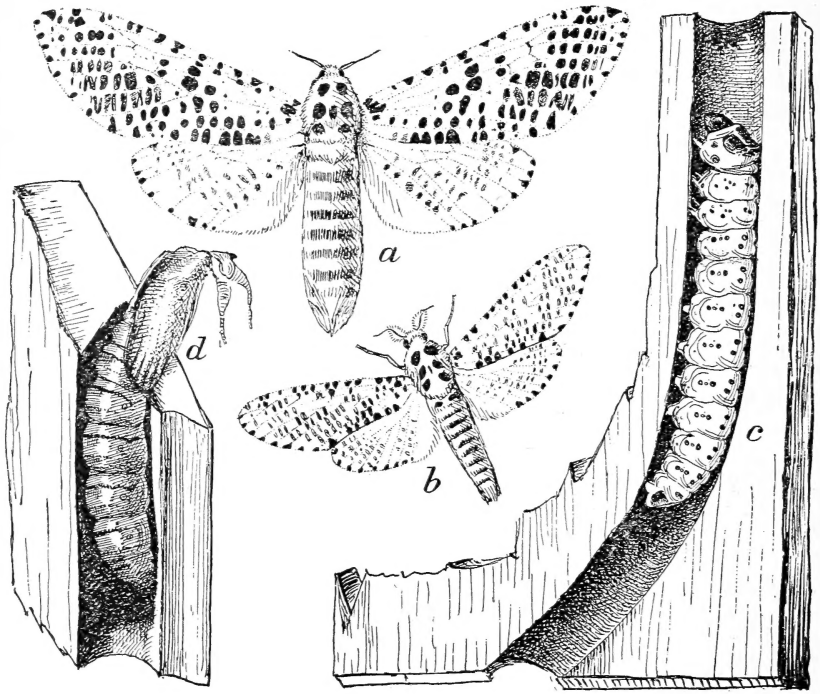

FIG. 1.—The leopard moth (*Zeuzera pyrina*): *a*, Adult female; *b*, adult male; *c*, larva; *d*, empty pupal case. Enlarged. (Original.)

session of broad bipectinate or feathery antennæ. The wings are semitransparent and white, thickly dotted with blackish spots which are more or less distinctly tinged, giving them a dark blue or greenish cast. The thorax is marked with six large black spots and one small one, the latter being located in the center. The female has a wing expanse of upwards of one and a half inches, while that of the male is much less.

An empty pupa-case in its cell in the wood is shown in the illustration at *d*.

ORIGINAL HOME AND DISTRIBUTION.

The leopard moth, like so many other dangerous pests, is a European species which has been introduced into the United States in comparatively recent years. Its old world distribution is credited as central and southern Europe, southern Sweden, southwestern Africa, Algeria, and northern Morocco, and the western portion of Asia Minor.

This species was introduced into the United States some time prior to 1879, in which year, on the authority of Mr. Jacob Doll, a living moth was captured in a spider's web at Hoboken, N. J.[a] In 1884 Dr. E. B. Southwick, then entomologist of the public parks of New York City, recognized the destructive work of this species in Central Park.[b] In 1887 it was seen at Newark, N. J., but was not actually recorded as occurring in this country until the following year. In 1890 the junior author observed the moths at electric lights at Orange, N. J.

Fortunately the spread of this insect, particularly in the immediate vicinity of New York City, has been very slow, a fact which may be attributed to several causes, (1) the slowness of the flight of the female, (2) the dominance of sparrows in large cities, causing our native birds, such as woodpeckers, to be driven to the country, where they destroy the moths, and (3) the bowl-shaped electric-light globes, hollow at the top and closed at the bottom, which were formerly in general use in our large cities. The males are strongly attracted to brilliant lights and many were captured and perished in these globes in earlier years. Other cities in New Jersey where this species has been troublesome are Elizabeth, Irvington, Montclair, Arlington, Asbury Park, Ocean Grove, and New Brunswick. Mr. H. M. Russell of this Bureau collected specimens at Bridgeport, Conn., in 1901. The species is now an inhabitant also of Staten Island and has spread on Long Island well beyond the confines of greater New York. Southward it was reported a pest, in 1901, at Ocean Grove, N. J., and by 1905 it was recorded by Felt as occurring at Kensico, N. Y., 25 miles north of New York City. By 1907 it was captured at New Haven, Conn., by Prof. H. W. Foote. It is now stated to be injurious in the vicinity of Boston, Mass.

FOOD PLANTS.

In its original home the leopard moth is recorded as living on a considerable number of common trees, including elm, lime or linden, ash, beech, birch, walnut, oak, chestnut, poplar, alder, and, rarely, horse-chestnut. Among orchard trees it is reported to do injury to pear, apple, and plum. In the United States it attacks all of these

[a] Entomological News, March, 1904, p. 110. [b] Insect Life, Vol. VII, p. 138.

trees and many others, the list including such important shade trees as have been mentioned, as also practically all of the maples, elms, and oaks, mountain ash, tulip tree (*Liriodendron tulipifera*), aspen, the willows, and such shrubs as privet, lilac, and honeysuckle. A list of trees which this species has been actually observed to attack was compiled in 1894 by Doctor Southwick and includes 77, observed in the public parks of New York City alone. A total list of 83 trees and shrubs was made at that time.[a]

It will be seen by the list of food plants already presented that the number could be almost indefinitely extended, particularly in reservations like Central Park, New York City, and Prospect Park, in Brooklyn, where special effort has been made to bring together a great variety of trees and shrubs. The insect is, in fact, nearly omnivorous, attacking, as previously stated, practically all forms of woody plants which are of suitable size for its purpose, with the exception of conifers.

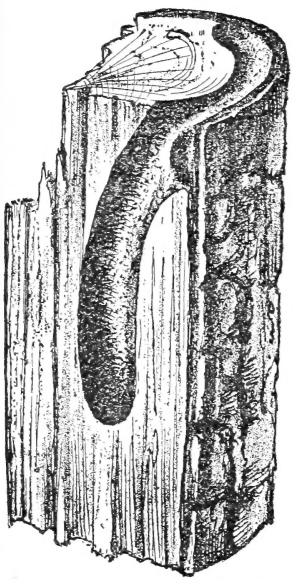

FIG. 2.—Section of wood showing burrow and girdling effect produced by larva of leopard moth. Reduced. (From Insect Life.)

HABITS AND LIFE HISTORY.

In Germany the moths are stated to make their appearance during July and August, while in this country they appear as early as May and continue issuing until late in September.

The gravid female, being particularly heavy, is unable to fly very far or very high. She deposits her oval, salmon-colored eggs in a large mass or group, when not in confinement, and as many as 300 eggs have been counted in a single mass. This is, however, probably not the maximum number, since an estimate of as many as 1,000 has been made. The eggs are introduced by the rather hard ovipositor into the soft tissue of young growth where the bark is smooth, or are inserted into crevices in the rough bark of older trees.

The larvæ soon hatch—in about ten days, according to Mr. J. V. D. Walker—and penetrate the wood, frequently entering the nearest crotch but boring in at other points, and burrow tunnels into the heart or pith of twigs and the heartwood of the larger branches or trunks. When a larva has grown too large for the branch in which it is feeding it crawls out and migrates to a larger one. In a single

[a] See list on page 529, Rep. Ent. N. J. Agr. Exp. Sta. for 1894. This article, by Dr. J. B. Smith, covers pages 517–533 and presents a very complete account of the insect.

tree 6 inches in diameter Southwick observed as many as six larvæ, any one of which would have been able to destroy the tree if not removed. Mr. A. Hufnal wrote that in maple trees which this species was infesting at Ocean Grove, N. J., there was an average of from six to eight borers to a tree and that he had found from ten to fifteen, and in one instance as high as thirty-four, in a single tree. By the time the larvæ within have attained full growth infested limbs of a certain size are likely to break off, especially during or after a severe storm, for the full-grown larva in many cases girdles the branch. The manner of girdling is shown at the top of the section of wood illustrated in figure 2. In 1893, after every storm in Central Park great quantities of limbs were seen, some entirely broken off and others still hanging to the trees.

The larva, when fully mature, transforms to pupa within the burrow, the change beginning to occur during the second May after the hatching of the eggs, the larva thus requiring nearly two years to complete its growth. The pupa, by means of a sharp protuberance on its head, is enabled to force its way partly out of the burrow, after which the skin splits open and the moth emerges. The empty pupal skin remains for some time projecting from the orifice.

The presence of this borer in a branch is manifested by little accumulations of chips, matted excrement, or frass, which indicate the entrance to the burrows. After a time these orifices are closed from within by a silken web, which is doubtless to protect the contained insect from its natural enemies. Smaller twigs wilt and break off and often it is only when the severed twigs or branches have been brought down in numbers by high winds that the work of the insect is first recognized. Where the larger larvæ have worked just under the bark this splits open the next season, leaving an ugly scar as a reminder of its pernicious operations.

NATURAL CHECKS.

No specific natural enemies of the leopard moth appear to have been recorded in this country, although in Europe E. A. Fitch has reared an indeterminate chalcidid of the subfamily Encyrtinæ.[a]

In the explanation of the cause of the slow spread of the moth from cities and large towns to the country, allusion has been made to the fact that native birds probably assist in holding this insect in check in the suburbs. Actual observations on this head appear to be wanting, but there are the best of reasons for believing that birds, like the woodpeckers, which naturally look over the bark and collect all kinds of borers, prey on this species, while it is believed

[a] Entom. Mo. Mag., Vol. XVIII, p. 116. Perhaps *Copidosoma truncatellum* Dalm., mentioned by Dalla Torre (not Mayr), Catalogus Hymenopterorum, p. 246.

that sparrows sometimes destroy the eggs or young larvæ in such places. Smith has expressed the belief that when the insect succeeds in getting away from the outskirts of cities its enemies increase in number, many insectivorous birds aiding in holding it down.

During the day the moths must be fed upon by birds and later by bats and night-flying birds. The habit of the larvæ of deserting one twig and migrating to a larger one undoubtedly leaves them exposed to the same natural enemies, as this has been observed to happen in the daytime as well as after nightfall. It follows that the protection of native birds, especially the woodpeckers and related species, will greatly assist in restraining the undue increase of this borer.

METHODS OF CONTROL.

The protected and concealed manner of life of this species, as shown by the life history, which will apply in the main to other borers also, renders it very difficult of treatment by means of insecticides or other direct measures. The most efficacious remedial measure consists in cutting off and destroying affected branches and in the injection of bisulphid of carbon into the holes or burrows where the larvæ are at work.

Pruning and cutting back.—Twigs or branches which, by their wilting or by the frass which accumulates at the entrance to their burrows, indicate the presence of this borer, should be carefully searched out, the smaller ones pruned away and the larger ones cut back, the amputated portions being promptly burned. After windstorms, the affected branches which have fallen to the ground and those which remain attached to the tree should be collected and burned. Wherever trees show that they are past recovery it is best to take them out and promptly destroy them. The word promptly is used advisedly, for this insect, as has been shown previously, frequently migrates from one twig or branch to another.

Bisulphid of carbon.—In the case of young and rare trees and others which show only a few larval burrows in the bark, bisulphid of carbon is the best remedy and one which has been in general use against the present species in the public parks of New York City. It is injected into the openings of the burrows, and the openings are afterwards closed with various substances. For this injection a mechanic's long-spouted oil can of small size may be used on large trees, but against a related species the writers have made very good use of a small glass syringe, such as may be purchased at any drug store for ten cents. These glass syringes are most serviceable, because the exact amount of bisulphid may be seen when drawn into the syringe and because the reagent does not injure the thread pack-

ing.[a] Metal syringes may also be used, but it is more difficult to measure the exact amount and the bisulphid acts on the leather packing. Rubber syringes can not be used because of rapid corrosion. About a teaspoonful of the liquid bisulphid is sufficient for each burrow.

For stopping the holes after injecting the liquid, putty and moist clay, advised by some, have not been found so serviceable as grafting wax. Coal tar may be substituted for the latter, or the holes may be closed by inserting a wooden plug and breaking or sawing it off level with the trunk. In any case the stopper should be tight, to exclude water from rains, which might tend to produce decomposition of the surrounding wood or invite other insects, like black ants and secondary borers, of which there are many species, and injurious fungi.

Carbon bisulphid should be handled with the usual precautions against fire, which means that the operator should not smoke while at work. Although a deadly poison, it will not injure ordinary trees when applied as described.

Killing with wires.—It is possible to reach and destroy some larvæ by forcing a copper or other pliable wire into the channels. This is a well-known borer remedy. It is impossible, however, by this means to kill the insects in all cases, owing to the length or crookedness of the burrows. Bisulphid of carbon should then be used.

Electric lights.—To what extent electric lights are serviceable as an agency in the destruction of the moths of this borer has not been definitely determined. Col. Nicholas Pike and Dr. J. B. Smith, however, have advised placing shallow pans around electric-light poles in and around parks to attract the moths. The pans are partially filled with water and a few drops of kerosene are poured into them. The moths flying against the globes drop into the pans and are promptly killed when they come into contact with the oil. In this way many males can be destroyed.

Inspection.—In large parks the destruction wrought by this borer annually is an important item, and it will be found a source of profit to establish a system of inspection consisting in the employment of parkkeepers and boys, and others who may be engaged at lower

[a] During the last years of the nineteenth century a long row of beautiful red oaks bordering the street between the grounds of the Department of Agriculture and those of the Smithsonian Institution were badly infested by the related carpenter worm (*Prionoxystus robiniæ* Forst.). Nearly every tree was infested and frequently two or three burrows showed near the tops of the trunks. Bisulphid of carbon was applied, as described above, and the holes closed with grafting wax. A year later no insects could be found at work, but wherever this remedy had been applied a small scar remained. Two years later these had entirely disappeared and the trees looked as if they had never been infested.

wages, to keep a constant lookout for evidences of borer attack on valuable trees. On this head Southwick has reported that in 1893 he spent two months in fighting this insect alone in the city parks of New York, collecting wagon loads of limbs and branches and destroying the larvæ or pupæ.

Maintaining trees in thrifty condition.—If valuable trees are to be protected, the insect should not be allowed to breed in useless growth. The borers in such trees should be destroyed or the trees promptly felled and burned. Care should be exercised in transplanting new trees, and fertilizers should be used in order that the trees may be always thrifty, the better to withstand attack. This means protecting them from the attack of aphides, scales, and defoliators, such as tussock moths and the fall webworm, and keeping them free from disease.

Finally, in the control of this species promptness and thoroughness can not be too strongly emphasized. The bisulphid of carbon remedy should always be used where applicable, and the inspection system advised should be instituted in all public parks and on city streets infested by this pest. Individual owners of valuable trees should become acquainted with the pernicious nature of this borer, and united action should be secured with neighbors who also suffer from the ravages of the pest.

NOTE.—After this publication was in type we received information that trees in the college yard of Harvard University, Cambridge, Mass., are being severely injured, the large elms being the most seriously attacked.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *May 27, 1909.*

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