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THE BAGWORM.

(*Thyridopteryx ephemeræformis* Haw.).

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

GENERAL APPEARANCE AND NATURE OF ATTACK.

Shade trees, shrubs, and hedges, and in particular evergreens, are much subject to injury by a medium-sized caterpillar which has a curious habit of crawling about on the infested trees in a bag-like case, whence its common name of bagworm or basket worm. In the shelter of these cases the insects undergo all their transformations, after which the bags remain attached to the plants for some time and are conspicuous objects on leafless trees and shrubs in late autumn and in winter. Like the tussock moth[a] and the fall webworm[b] this species is preeminently a pest on the streets and in parks and private grounds of cities and towns and is even more subject to fluctuation in numbers. It is, however, more limited in distribution and not found as a rule north of southern New York and the central portions of Pennsylvania and Ohio. South of these points it is in certain years very troublesome and the subject of much complaint. Such a year was 1907, when the bagworm attracted greater attention than any other tree defoliator. Numerous complaints were received of injuries in the region mentioned, and especially from the States of New Jersey, Pennsylvania, Maryland, Virginia, West Virginia, Ohio, Indiana, and Illinois. The natural enemies of this insect (see p. 6) were comparatively scarce, and there is a strong possibility of a recurrence of injuries in the years to come.

FIG. 1.—Bagworm (*Thyridopteryx ephemeræformis*). Natural size (after Riley).

The general appearance of the bagworm is shown in figure 1, which illustrates the caterpillar when nearly full grown, in its characteristic bag. When removed from its bag it looks as shown in figure 2, *a*, which represents the larva at maturity. At this period in its develop-

[a] *Hemerocampa leucostigma* S. & A. [b] *Hyphantria cunea* Dru.

ment it may attain a length of about three-fourths of an inch. The body is soft in texture and dull brownish or blackish, while the head and thoracic segments are horny and whitish, mottled with dark brown.

ORIGINAL HOME AND PRESENT DISTRIBUTION.

The bagworm is unquestionably native to North America. It abounds in the Southern States, and its proper home—that is to say, the part of the country where it reaches its maximum—is in the Lower Austral life zone. It extends through a considerable portion of the Upper Austral zone, but there are indications that it has gradually spread into this territory from more southern regions.[a] The shade trees of Baltimore, Washington, St. Louis, and other more southern cities are frequently defoliated by this insect. Northward it occurs

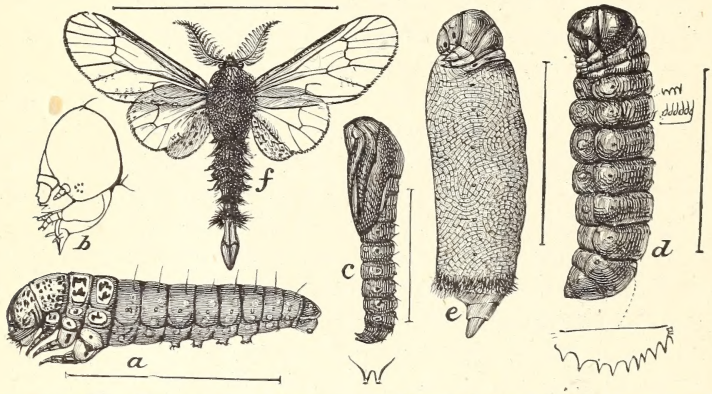

FIG. 2.—Bagworm (*Thyridopteryx ephemeræformis*): *a*, Full-grown larva; *b*, head of same; *c*, male pupa; *d*, female pupa; *e*, adult female; *f*, adult male. All enlarged (from Howard).

through New Jersey and at many points in Pennsylvania, including the cities of Harrisburg, Elliottsburg, Allentown, and Swarthmore. Farther west it has been found at Columbus, Marietta, South Salem, and other localities in Ohio, at several points in West Virginia, at Brooklyn, Ind., in Pecatonica, Thompsonville, and Allendale, Ill., and so on west to Oklahoma. Everywhere south of these localities, except in the immediate Gulf region, it abounds. In the East it is commonly found in New York City and Brooklyn, and at several points on Long Island. In the Hudson River Valley region it has been recorded by Felt at Yonkers and Mount Vernon, and has been collected at New

[a] In the main the bagworm is one of those characteristic forms like the wheel-bug (*Arilus cristatus* L.), the Carolina mantis (*Stagmomantis carolina* L.), and the larger digger wasp (*Sphecius speciosus* Dru.), true southern forms which are gradually extending their northward range by following the seacoast or valleys, or, if carried accidentally northward upon railroad trains, establishing themselves at points beyond their former habitat.

FIG. 3.—Arborvitæ infested by bagworms. (Original.)

Haven, Conn., but it is not known to be injurious in these localities. It has been sent to the Bureau of Entomology from Springfield, Mass., but probably does not breed there.

FOOD PLANTS.

The bagworm, although a very general feeder, displays a particular fondness for evergreens of all kinds and especially for arborvitæ, hence it seems probable that one or the other of these was its original or normal food plant (fig. 3). The species becomes exceedingly abundant every few years, and at such times it may be found on shade, orchard, and forest trees of nearly all kinds. It is fond of the maples, particularly the cut-leaved and silver maples, and the related box elder; also of the poplars and mulberry, less so of the elms, and apparently still less so of the oaks. It feeds more or less freely, however, on most other trees and shrubs, and even on many low-growing semi-woody plants, such as elder, mallows (Hibiscus), and ragweed (*Ambrosia trifida*). Thus, in the absence of its choice food plants, it is able to subsist on the foliage of almost any of the plants of the character enumerated and which may be available, but it does not seem to live on grasses and herbaceous plants generally.

HABITS AND LIFE HISTORY.

The bagworm overwinters in the egg stage within the old female bags, and for this reason hand-picking in winter time is an efficacious remedy. In the late spring the young hatch from the eggs, crawl out upon the twigs, make their way to the nearest leaf, and immediately begin to feed and to construct cases or bags for themselves. They spin a large amount of silk and attach to it, for additional strength and protection, bits of leaf or of twig, evidently attempting to disguise the nature of the case as well as to strengthen it. The larva is remarkably soft-bodied, except for its head and strong thoracic plates, and it is necessary that the soft abdomen should have some protection. The construction of the bag of an allied species was carefully studied by H. G. Hubbard, and it is a very interesting performance.

The young larva (fig. 4, *a*) cuts off with its jaws a small fragment of leaf which it places between its front legs, gradually forming a pile fastened loosely with silk. When the pile becomes a transverse tangle about as long as the body it is fastened at each end loosely to the surface upon which it rests; then the caterpillar, after placing itself at right angles, dives under the mass, turning a complete somersault, so that it lies on its back, bound down by the fillet. It then twists around and stands upon its feet, having its neck under a sort of yoke (fig. 4, *b*). It makes the yoke into a complete collar, adding bits to each end until

the circle is complete. Then row after row of fragments is added until the case becomes a hollow cylinder (fig. 4, *c*). One end is then closed up and the inside lined with a tough coating of silk, the case being then extended upright and fastened at one end. When it is fully completed the larva crawls away, with the case carried upright like a cap on the upturned end of its body. In the illustration *d* shows a completed bag made by the young larva, tightly appressed to the flat surface, the larva being concealed within. Such bags may frequently be found on leaves, and are quite puzzling to the uninitiated until the larva pokes out its head and slowly walks off. As the caterpillar grows the case is constantly enlarged, bits of twigs and any other small objects being used to ornament the outside, and these objects will vary with the kind of tree upon which the caterpillar is feeding. While the larva is small it carries its case erect, but when it is larger the case hangs down (fig. 1). The larval skin is cast four times, and during the molting the mouth of the bag is kept closed with silk. There is a small opening in the extremity of the bag through which excrement and cast skins are pushed. The male bags are smaller than those of the females, reaching a length of about an inch, while those of the females are much larger. Toward the end of August, about Washington, D. C., the larva completes its growth, attaches its bag firmly by a silken band to a twig, strengthens it inside with an additional layer of silk, and within this retreat, which now becomes its cocoon, transforms to pupa with its head downward. The pupal period lasts about three weeks, and then the imago emerges. The male chrysalis works its way out of the lower opening, and the winged moth issues

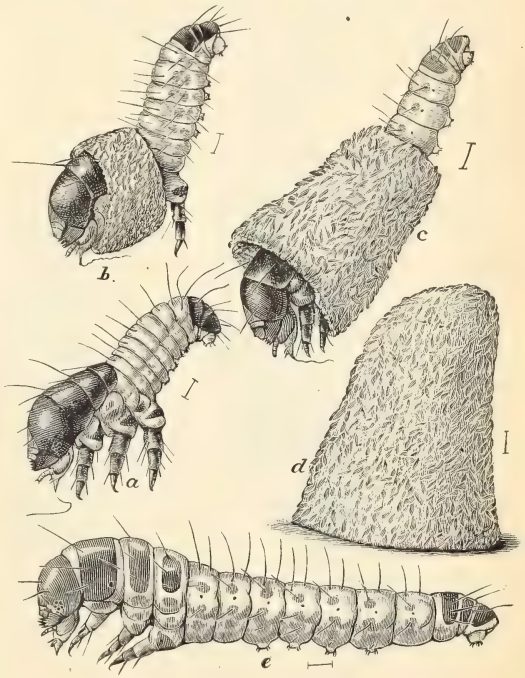

FIG. 4.—*a*, Newly hatched bagworm before making its case; *b*, same just beginning case; *c*, showing case nearly completed; *d*, completed case, insect concealed within; *e*, larva after first molt. Highly magnified (original).

through the cracking skin, leaving the chrysalis hanging from the bag, as shown at *c*, figure 5. The chrysalis of the female does not push its way at all out of the bag, but the skin cracks and the female gradually works her way partly out, her head reaching the lower end of the bag, (fig. 5, *d*). The males fly about, seeking the bags of the females, and when one is found in which the head of the female is near the end, showing that she has emerged from her chrysalis skin, the male pushes his enormously protrusive and, in fact, telescopic genital apparatus up into the bag to the anal end of the female and fertilizes her. The female then works her way back into the chrysalis skin, gradually filling it with eggs until more than half of it is filled, scattering in among the eggs some of the sparse hairs from her body. Having done this she forces her shriveled body out of the opening, falls to the ground, and dies. The eggs remain in this way until the following spring, when they hatch, as previously described.

There is thus only one generation annually.

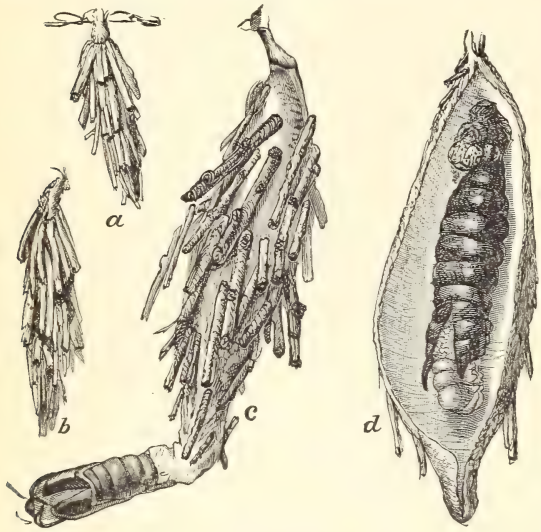

FIG. 5.—Bagworm at (*a*, *b*, *c*) successive stages of growth. *c*, Male bag; *d*, female bag. Natural size (from Howard).

NOTE.—There is a possibility that the bags of this extremely common insect might be made commercially useful. Its silk, from a practical standpoint, has always been ignored, but it is firmer and stronger and more easily spun as carded silk than that of most other native silk cocoons.

NATURAL ENEMIES.

Although apparently well protected from the attacks of birds by its tough case, the bagworm is somewhat extensively parasitized by several forms of ichneumon and chalcis flies, most of them species which affect also similar tree-feeding caterpillars. Prominent among these is the common *Pimpla inquisitor* Say (fig. 6), which, however, more commonly parasitizes the tussock moth and tent caterpillars.[a] The related *P. conquisitor* Say is also a parasite of the bagworm and a third species of ichneumon, *Allocota* (*Hemiteles*) *thyridopterigis* Riley (fig. 7), is usually the most abundant of all. Four or five individuals of this species commonly infest a single bagworm, spinning for themselves white silken cocoons within the bag.

[a] *Malacosoma* spp.

The species last mentioned was for many years credited with being a primary parasite of the bagworm, although recent observations would indicate that it is a secondary parasite when infesting other

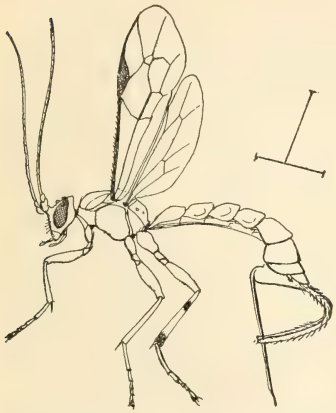

FIG. 6.—*Pimpla inquisitor:* Female, from side. Enlarged (from Howard).

FIG. 7.—*Allocota* (*Hemiteles*) *thyridopterigis.* Much enlarged (original).

caterpillars. This might be explained by the hypothesis that this parasite oviposits only in cocoons or cases of firm texture, and therefore can not be the primary parasite of an insect which is not provided with a case of that character.

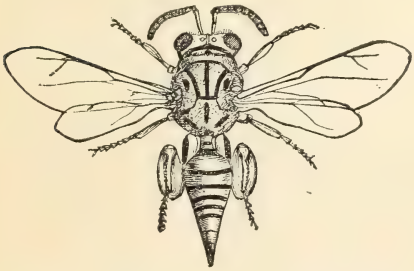

FIG. 8.—*Spilochalcis mariæ.* Much enlarged (after Riley).

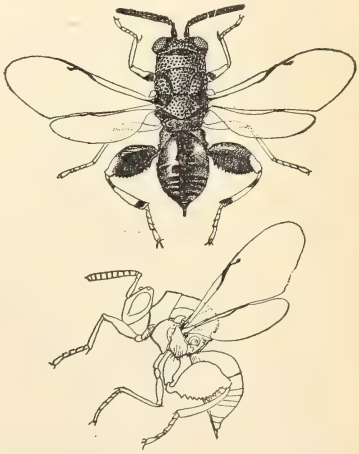

FIG. 9.—*Chalcis ovata:* Adult. Enlarged (from Howard).

Certain chalcis flies also breed in the bags of this insect. These include *Spilochalcis mariæ* Riley (fig. 8), *Chalcis ovata* Say (fig. 9), and the common little *Dibrachys boucheanus* Ratz. (fig. 10). This last is a hyperparasite, in the case of the bagworm probably secondary, and in the case of other caterpillars a

tertiary parasite. *Habrocytus thyridopterigis* Ashm. (fig. 11) is assumed to be a tertiary parasite on *Allocota thyridopterigis* Riley, when the latter is a secondary parasite of the tussock moth, but may be secondary when breeding in the cases of the bagworm.

REMEDIES.

When the bagworm occurs upon deciduous trees it can be controlled by hand-picking the bags in the winter, but when it affects evergreen trees it is practically impossible to apply this remedy with profit unless the plants are badly defoliated. Therefore for the treatment of evergreens spraying is a necessity.

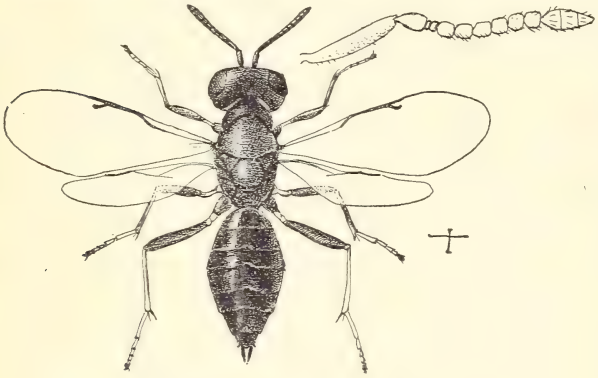

FIG. 10.—*Dibrachys boucheanus:* Adult female and antenna of male. Much enlarged (from Howard).

The methods of controlling shade-tree pests in cities and towns, as outlined in Farmers' Bulletin No. 99,[a] on pages 25–29, are in part applicable to this species. This bulletin should be read by persons who have experienced trouble from the depredations of the bagworm.

Collecting the bags.—One of the most important remedies consists in gathering the bags with the contained insect by hand and either burning them or preserving them to liberate the useful parasites which have been previously mentioned. This work may be facilitated by the use of a 12-foot pole pruner or similar appliance, and can be intrusted to those ordinarily unemployed, such as children and aged persons. Where the trees are very tall it will be necessary to use a long ladder. For best results the cooperation of neighbors who are troubled with the same pest should be secured.

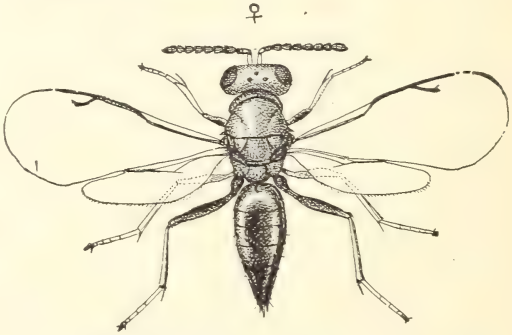

FIG. 11.—*Habrocytus thyridopterigis.* Greatly enlarged (from Howard).

[a] This publication may be had gratis on application to the Department of Agriculture.

Very considerable immunity from future injury will result by care in the employment of this method. It is particularly useful where only a few trees are infested. The bags are such conspicuous objects on defoliated or bare trees in winter that it is not at all difficult to detect them, but in cases where comparatively few insects are present on evergreen trees they are not so easily seen.

Encouraging the parasites.—When many trees are infested it is advisable to keep the hand-picked bags for a considerable time in receptacles, such as barrels covered with netting, preferably of wire, so that the numerous beneficial parasites of the pest will be able to issue in the spring and assist in the control of the bagworm the following year. One or two holes bored in the bottom of the barrel or box will prevent water from accumulating and drowning the insects. Where the bags can be placed in piles in an open space or inclosure distant from trees and free from disturbance, the young insects, having very limited powers of locomotion, will soon perish of starvation, as they will not be able to reach the trees or shrubs after they hatch.

Spraying with arsenicals.—On evergreen, where the bags are more or less difficult to find, hand-picking can not be advised. A striking instance of the futility of this method under such circumstances was given by Prof. C. V. Riley in his testimony at a conference on the gipsy moth in 1891. He said that he once tried to protect a cedar tree not more than 6 feet high, upon his own grounds at Washington, by hand-picking. He worked for two consecutive months picking off small bags from that tree, the progeny of not more than two females. Almost daily he went to the tree and found fresh specimens which he had overlooked the day before. For evergreen trees, therefore, an arsenical spray is the best remedy. In connection with the story of his experience just related, Professor Riley stated that he had absolutely stopped injury by the bagworm on large trees in the Smithsonian grounds by spraying, and in the summer of 1895 we had a similar experience on the grounds of the Agricultural Department at Washington. Trees sprayed with Paris green at the rate of 1 pound to 150 gallons of water were completely rid of larvæ of the bagworms. It is easier to reach the bagworms on evergreen than on large-leaved deciduous shade trees, such as maple and elm, but if carefully carried out spraying will result in the destruction of the bagworms, so that the collection of the bags in winter will not be necessary. Arsenate of lead at the rate of 1 pound of the prepared paste form to from 25 to 50 gallons of water will be found even more useful than the Paris green, as its greater adhesiveness renders it less likely to be washed off by rains, which in some seasons frequently occur almost daily at the time when the larvæ are beginning to work.

The best time to apply the arsenical is when the eggs hatch, or shortly afterwards, and the best methods of spraying shade trees are discussed in Farmers' Bulletin No. 99.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *December 2, 1907.*

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