LIFE-HISTORY OF THE HEMLOCK MEASURING-WORM

Ellopia fiscelleria

Thesis for the Degree of M. S.

Charles Bradford Dibble

1927

Insects, Injurious + Beneficial
Title: Hemlock looper

LIFE-HISTORY OF THE HEMLOCK MEASURING-WORM, *Ellopia fiscellaria*.

THESIS FOR DEGREE OF M.S.

MICHIGAN STATE COLLEGE

Charles Bradford Dibble
1927

THESIS

Ellopia fiscellaria Gn.

The Hemlock Looper

Considerable damage to coniferous trees occurring during the summer of 1925, Hemlock and Balsam suffering in particular, in the resort region of northern Michigan, brought this insect to the writer's attention. The following account is a record of observations made in an effort to determine the best methods of control applicable in the infested areas. With this in mind, a survey, to determine the extent of the infestation, was made covering nine counties in the northwestern part of the state and data were collected on the seasonal development.

Following this work, which occurred in 1925, frequent attention was directed toward the pest in 1926, resulting in the acquisition of additional data.

The survey, for the most part, was made on or near the principle highways in the infested regions. All stands of Hemlock encountered were investigated, and wherever living examples of the looper were found, a record was made of the exact location and the stage of development in which the insect was found.

In addition to the field work, material was constantly under observation in breeding cages located at the Michigan State College. Other cages were used in

the field to facilitate field observations.

CLASSIFICATION

Determinations of this insect were very kindly made for us by Dr. Dyar of the Bureau of Entomology of the U.S.D.A.

Larval specimens were first determined by him as Ellopia sp. and later when adults were available he specifically placed the insect as Ellopia fiscelleria Gn.

This species formerly bore the name:- Therina fiscelleria Gn. (Lepidop. of N.A. - Smith, p.66).

COMMON NAMES

As no common name has been found in the scant records of this insect, the title Hemlock looper is preferred. This name is suggested by the creature's family habit of locomotion and by the fact that Hemlock seems to be the preferred food-plant.

EARLY HISTORY

Our first authentic record of serious damage done by the Hemlock looper dates back to 1924. At that time, rumors reached us of insect ravages peculiar to coniferous forest growth in the northern part of the state. Later investigation proved these rumors to be centered on the work of the insect under discussion. During 1925 the first real contact was established between the entomologists of this state and the work of the Hemlock looper.

Previous to this time defoliations have occurred on hemlock, and although there are no authentic records of outbreaks in Michigan, hemlocks have been killed by foliage-eating insects. The evidence is fragmentary and only carried in the memories of "old timers", lumbermen, or workers who formerly spent a large part of their time in the "big woods". The character of the work, as remembered, and of other somewhat elusive facts seems to point to Ellopia sp. as the depredator. In view of these facts, it is not unlikely that Ellopia fiscelleria Gn. has visited our forests in numbers previous to 1924.

About twelve years ago, the hemlock in Montmorency County was defoliated and in many cases killed, requiring a salvage cutting to save the timber. This was observed by Mr. J. H. Cahoon of

Cheboygan, who also remembers a flight of moths in the woods that fall. This gentleman was working in the woods at the time and had an excellent opportunity to observe the phenomenon.

Farther back, about twenty years ago, the hemlock on an island in Grand Traverse Bay, now owned by Henry Ford (Ford's Island), was defoliated and killed. There is little information available on this particular depredation, but there is a possibility that the same species was responsible.

DISTRIBUTION

Throughout the summer and autumn of 1925, word reached us of other serious outbreaks of insects affecting coniferous foliage. Reports came from New York, Ohio and Wisconsin and the work seemed to be that of a similar insect, as in each case hemlock was one of the principle food plants.

At a later date this suspicion was confirmed in two cases of the three. The third, occurring in New York, proved ill founded, the insect being determined as entirely different.

Professor J. S. Houser of Ohio reported considerably widespread damage from that state in 1925 by a related species.

From Wisconsin, comes a report by F. B. Fracker, State Entomologist of Wisconsin, of damage occurring in that state.

In Michigan the serious damage during 1925 was confined to five more or less distinct areas. All of these were located in resort sections in the northwestern part of the state.

A survey of nine counties demonstrated the fact that the infestation was very general. The insect was found wherever hemlock occurred in abundance.

Below is a list of the more heavily infested areas found in 1925, and following these is another record of a heavy infestation located during 1926.

1925

Leeland Infestation	-	Leelanau Co.	250 acres
Old Mission "	-	Grand Traverse Co.	180 "
Birch Lake "	-	Antrim Co.	200 "
Elk Lake "	(East Side) -	Antrim Co.	180 "
Cross Village "	-	Emmet Co.	160 "

1926

Herring Lake Infestation - Benzie Co.--------100 acres

In addition to these areas of principle importance the insect was found in the following counties and townships:

Leelanau County

Leelanau Twp.

Leland Twp.

Cleveland Twp.

Empire Twp.

Salon Twp.

Grand Traverse County

Garfield Twp.

Peninsular Twp.

Mater Twp.

Benzie County

Lake Twp.

Blain Twp.

Manistee County

Arcadia Twp.

Springdale Twp.

Antrim County

Elk Rapids Twp.

Milton Twp.

S. Milton Twp.

Helena Twp.

Central Lake Twp.

Charlevoix County

Norwood Twp.

Emmet County

Cross Village

Otsego County

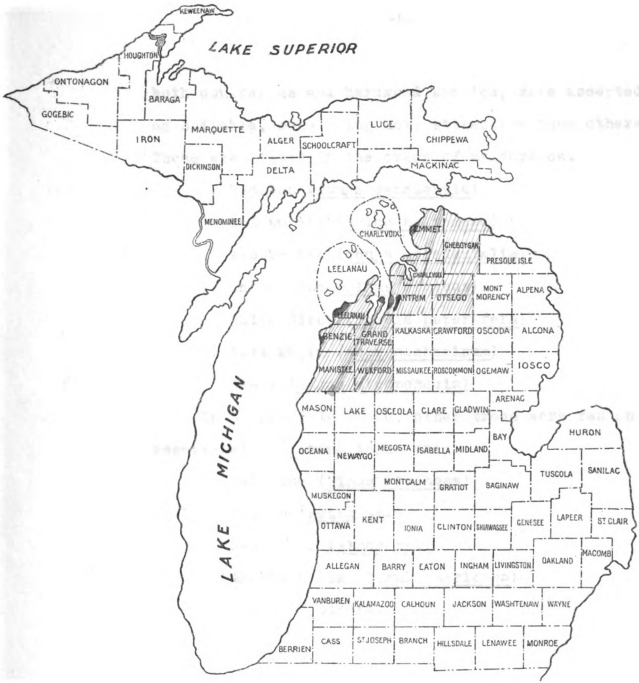
Gaylord Twp.

Alba Twp.

In order that the surveyed area and the heavily infested areas may be apparent at a glance a map has been included in this account. The fact that the loopers were found wherever hemlock occurred, with few exceptions, would lead one to believe that it was common, in such locations, all over the northern Lower Peninsula. We have no records of its occurrence in the Upper Peninsula, although word did reach us of damage done to hemlock in that part of the state. The creature is a native of the North Central States and undoubtedly is always with us. The recent outbreak being due to an upsetting of the balance normally maintained between the moth and its natural enemies.

FOOD PLANTS

Decided preference was in all cases shown for hemlock as a food plant. However, many other trees,



Red - Indicates Killing Infestations 1925-1926.

Green - Indicates Area Included in Survey.

both coniferous and hardwood species, were accepted as suitable, some being more attractive than others. These are listed in the order of preference.

Hemlock (Tsuga canadensis)

Balsam Fir (Abies balsamea)

Arborvitae (Thuya occedentalis)

White Pine (Pinus strabus)

White Birch (Betula paperifera)

Soft Maple (Acer saccharinum)

Beech (Fagus atroponecia)

In addition to these, other trees were fed on occasionally. Among these are:

Red Pine (Pinus risinosa)

Willow (Salix sp.)

Tag Alder (Alnus sp.)

American Elm (Ulmus americana)

And some others.

RELATED INSECTS

A very close parallel to the damage occurring in Michigan was also suffered in Ohio at about the same time. This damage I am informed by Professor J. S. Houser, Entomologist of Ohio State College, was due to the work of a related species, Ellopia athasaria, identified by Dr. Karl Heinrich.

About 1908 L. W. Sweet recorded finding a variety of Ellopia fiscellaria at rest on trees at Forest Hills, Boston. These were found from September 15th to 20th. The variety was named Therina (Ellopia) fiscellaria peccataria N.Nor.

Another related species and one apt to be confused with E. fiscellaria is Ellopia (Therina) fervidaria. Specimens bearing each of these names are to be found in the collection at the Michigan State College, recorded as No.3406 (3 males, 1 female) and No.3407 (3 males) Ac.1774, respectively.

Another species, Ellopia sominaria is found recorded as damaging coniferous trees at Stanley Park, Vancouver Island, B.C., from 1911 to 1913. A material decrease in the infestation, probably due to parasites, occurred during 1914.

INJURIES AND LOSSES

In the summer of 1925 the hemlock and balsam trees in Michigan defoliated during the previous season were dead. This damage was not extensive, however.

During the following season, 1926, the effects were more noticeable as widespread killing had resulted from the 1925 defoliation. Large areas in the infested region appeared as though "struck by fire". Trees of all sizes, from seedling and small-pole material to fully matured, monarchial specimens alike, were leafless and dead.

In some cases, feeble attempts toward recovery were being made, by such trees as were not totally stripped, but with the recurrence of the worms during the season of 1926 small hope could be cherished, of even these few recovering sufficiently to live. A striking example of the death of hemlocks due to the attack of the looper, occurred at the Old Mission Lighthouse Point. The stand of trees on this point could well be considered as pure hemlock, and very few trees escaped destruction. The damage became apparent during 1926 in all of the heavily infested areas but because of its pure nature, the damage on this site was very striking.

The greater part of the several severe losses occurred on property having a high aesthetic value

for which the tree growth was in a way responsible, and in consequence, an estimate of the loss of value involved would be purely hypothetical. Where property was held for forestry purposes, the damage occurred in areas of growing stock and appraisals in such stands are, of course, difficult to make.

The heavier losses were no doubt suffered by those owners who had in mind both the aesthetic and the commercial value in encouraging tree growth on their lands. Some few regarded the hemlock growth with disfavor and really felt no resentment toward the worms for giving them an excuse to remove dead timber as salvage material. This view was of course entertained by comparatively few owners.

In the Birch, and Elk Lake areas, Arborvitae, Thuya occidentalis, was extensively worked upon during 1925, but inspection during the following season revealed no killing of arborvitae, no doubt due to the fact that less "clipping" of foliage was probably done by the worms on arborvitae than on hemlock. Arborvitae seems to be accepted as an auxiliary source of food but the resulting loss of foliage was not as severe as in the case of hemlock.

From Wisconsin comes a report by F. B. Fracker of damage by this species during 1925. The infestation occurred, according to his report, in the Penninsula State Park in Door County north of

Sturgeon Bay.*

*(Jour. Econ. Ent., Vol.18, No.6, Dec., 1925).

DESCRIPTION

Larvae -

The larvae are typical Geometrids and in late July, 1925, were about 3/4 of an inch in length. As the season advanced, they became larger, and late in August all had reached a length of about one inch and some were one and one-quarter inches long.

During 1926 the larvae varied on July 15th from one-half to three-fourths of an inch in length. They were much more slender and smaller in appearance than the first specimens taken during late July of the previous season. Later in the season, August 15th, the larvae were apparently nearly full grown.

The color of the larvae is pale, yellowish-green though some individuals are a distinctly grayish. Possibly this is a varietal or specific differentiation, but as yet we have been unable to prove either, by breeding the adults separately. A double row of black dots appears on the back. They occur in groups of four on each dorsal segment. These dots are very distinct in the fore and central portions of the dorsum. One row of black dots occurs in pairs on

LARVAE OF

Ellopia fiscelleria

PUPAE OF

Ellopia fiscelleria

ADULT OF

Ellopia fiscelleria

each lateral margin with some black splotches on the sides.

Pupae -

The fresh or newly formed pupal cases are pale yellowish-green, mottled with brownish-black spots and dashes. The cases darken with age, finally reaching a dirty tan with the black markings still present. The wing cases are of a darker brown color and are not mottled. Each pupal case is from 7/16 to 5/8 inches in length.

Adult -

In both sexes the adults are very similar. The gravid female, of course, has her abdomen distended somewhat by the enclosed egg mass and appears more heavy of body. The male antennae are feathered while those of the female are threadlike.

The ground color is yellow-tan or a yellow with minute tan flecks, and the markings are the same in both sexes. The wings are darker above due to a dense sprinkling of smoky splotches.

The fore-wing is crossed by two dark, or smoky bands, the first preceded and the latter followed by a distinct bordering yellow or ocherous band. A dark or smoky discal spot occurs between the bands near the outer margin of the wings.

The rear-wing is crossed by a single ochreous-bordered, smoky band which corresponds in position to the second or anal band on the fore-wing.

Beneath, the wings are pale; the lines and discal spot appear but are indistinct. The wing expanse varies from one and one-eighth to one and one-half inches.

The body of the moth is yellowish in color and about three-quarters of an inch in length. The male abdomen is slender, that of the female being shortened and broadened by the enclosed egg mass. Greenish lines appear between the ventral abdominal segments of the distended abdomen of the female.

Egg -

The eggs when deposited are about .5 mm. long, somewhat elongate or oval in shape. In color they are irridescent gray-green. As they age they may change color, becoming shining brown.

EGGS ON WHITE CEDAR FOLIAGE

LIFE-HISTORY AND HABITS

Egg -

The egg stage of the hemlock looper's life covers the major portion of its existence. The eggs are deposited from early to mid September, under bark-scales, or between the needles of coniferous trees, and in hardwood leaves which have fallen and lodged in the webbing in defoliated trees. It is probable that occasionally eggs are deposited on hardwood leaves on the ground, or on leaves which later fall to the ground and become litter. On the 23rd of December, 1926, large numbers of eggs were found on rolls of birch-bark and leaves in the infested area, at Herring Lake.

Late in the fall or during the winter, some of the eggs, resting on dark surfaces, lose their green color and become brown. For the most part those found at Herring Lake still retained their original irridescent, gray-green color, as in this area birch was abundant, and the eggs were most commonly found in the rolls of birch-bark.

Some of these eggs were brought to East Lansing, and at the time of this writing, they are still in breeding-cages in the cold room of the insectary. The hatching date will be recorded later, provided they develop in a satisfactory manner.

Larvae -

Although we have not as yet observed the hatching of the eggs of this species, it probably occurs about the first or the second week in June. The writer has observed larvae during the first week in July and at that time the loopers are large enough to be conspicuous. By July 15th they had reached a length of from ½ to ¾ inch in 1926, and on July 18th, 1925, they were about the same size or possibly on the average somewhat larger. Their linear measurement at that season does not increase as rapidly as the diameter. In other words, the worms begin to become more thick-set.

The larval stage continues until mid or late August at which time "worms" attain a length of 1 to 1¼ inches. Just previous to pupation the body shortens and thickens, the larvae cease feeding, each one builds a crude, loosely constructed, silken cocoon and becomes quiescent.

Feeding continues throughout the active larval development. The needle is most often attacked on one side near the tip and a notch is left in the side of the needle when the meal is finished. The damage is often more extensive than this, however, as many needles are clipped from the twigs and fall

directly to the ground, or else become entangled in the webbing in the trees, in large masses, to reach the ground later.

The attack, en masse, on each tree begins near the top and progresses downward, the larvae spinning silken cords from branch to branch. They leave behind barren twigs and a silken network of web. Wherever the worms occur in numbers the trees are completely defoliated. If the worms reach the ground before their growth is completed they redistribute themselves on the ground surface and climb other trees on which to feed.

A heavy jar, or bump, on an infested tree will cause many of the loopers to loosen their holds on twigs and fall, to hang suspended in the mid-air by almost invisible silken threads. Resorters in the infested areas objected to this habit because of the tendency of the worms and their webbing to get entangled in the hair and on the clothing of passers-by.

The worms object to being pinched in one's collar and reciprocate by biting rather viciously at the offender's neck. Although the bites are unpleasant, no swelling or subsequent prolonged irritation results from them.

Having reached a well fed old age, each larva

seems a protected place, becomes inactive and pupation occurs.

Pupae -

Once a larva has decided to pupate and has selected a suitable location in which to undergo the operation, the body shortens and thickens. In some cases two days or slightly more are required for the process to be completed.

The loopers show discrimination in the selection of a location for the cocoon. It must be protected from water. Many of them hide beneath bark scales, under dead areas of bark, or tangle themselves in the webbed masses of needles hanging in the infested trees. Many are found in rolls of birch-bark wherever these trees occur close at hand.

Occasional cocoons are found beneath sticks, stones or leaves on the ground, but these latter locations are not commonly selected. They do not seem to afford sufficient protection to please the loopers and are used only as a last resort.

Often the cocoons are deeply imbedded in rotting logs or stumps. Here the larvae have apparently crawled into the tunnels of wood borers. In such places they often utilize the loose frass present to help construct pupal chambers. The pieces of frass are bound together by webbing and the pupa rests very

PUPAL CASES BENEATH DEAD BARK

comfortably in this padded retreat.

Pupation extends over a period of from eight to fourteen days or slightly less, as observed both in breeding-cages and in the field, permitting the moths to emerge about September first.

Adults -

Emergence of the moths began in the breeding-cages at the College on August 28th during 1925, and the first moth emerged from caged material, obtained in the field on August 30th. The first adults were observed by the writer in the field, on September first, at Elk Rapids. The full flight occurred about September third. In 1926 the flight was somewhat delayed, probably by the season, and started about September eighth.

The general coloring of the adult moths is light, becoming protective when the moths rest on light surfaces. They were observed resting, during the daytime, on every available surface, foliage, trunks, branches, rubbish, litter, and on the sides and beneath the eaves of buildings. On September 3, 1925, many males were noted on soft maple foliage, on white cedar foliage and on the trunks of white birch trees.

In all cases the moths show a tendency to hide. Many rest with only their heads and the front part

of their bodies covered by a projecting bark flake, or beneath the rolls of bark commonly found on the white birches.

The adults are not day-fliers by preference and remain inactive unless disturbed. However, when the dusk of evening approaches, the situation changes and the woods seem to be full of flying moths.

Strong electric lights do not offer any attraction, some few moths fly near electric lamps and may alight on nearby foliage, but many leave at once without approaching the source of illumination. After mating begins, a larger number pause in flight and rest near by on lighted surfaces. No mating was observed by the writer in well lighted areas, although both male and female moths were present in about the same proportion that they occurred in the woods.

Mating begins about seven or eight days after emergence and lasts for several days. At emergence, the females carry quite large egg sacs, but no mating was observed in 1925 until September 9th and by September 15th many mating pairs were to be found in the woods. The temperature during the mating period ranged between 58°F and 62°F. The mating period seemed to reach its height on September 11th.

Mating usually occurs on the trunk or lower branches. On the trunk the pair rests in a vertical position with the female above the male. When on branches or twigs the pair hangs suspended beneath, both individuals clinging to the branch. Copulation probably does not require more than thirty minutes and may be repeated, by the female at least, especially if the pair is disturbed before the process culminates naturally.

Following copulation, eggs are deposited in from one to three days. Mated females taken on September 9th deposited eggs the night of September 12th in breeding-cages. The egg-laying in the field started about this time also as some females were taken with shrunken abdomens and others were observed moving about with their abdomens extended and curved downward, apparently searching for a suitable place to oviposit. None were observed in the process of oviposition, as they became frightened when a light was flashed on them and refused to oviposit under observation.

On September 4th eggs were found in all of the cages in considerable numbers. Some females taken mating on September 3rd, deposited eggs at this time. Those same females were placed in a large cage with some hemlock bark, hemlock foliage, and some cedar foliage. Counts were made of the

number of eggs deposited on each are tabulated below.

	Hemlock bark,	Hemlock foliage,	Cedar foliage
Sept. 15,1925	9	10	2
	13	58	61

From this data it is apparent that some preference was shown for foliage as a place for egg deposition in the cages. Under field conditions, this could not be accurately checked. In addition to the above mentioned locations, eggs were found during 1925-1926 on Red pine bark, White pine bark, in rolls of birch-bark, and on suspended hardwood leaves. In the Herring Lake area during 1926 preference was shown for the birch-bark, possibly because of its abundance throughout this area.

Natural Enemies -

Several parasitic forms were taken from the breeding cages in which the looper material was handled. These were very kindly identified for us by Mr. K. A. Cushman, U.S.D.A., Washington, D.C., as follows:

Amblyteles nelar	Cress	Lot.1537-40	College Collection	MSC
Ephiates pedalis	Cress	Lot.1537-41	"	"
Amblyteles puerilis	Cress	Lot.1537-42	"	"
Itoplectis conquisitor	Say	Lot.1537-43	College Collection	MSC

These forms were not abundant in the field and probably were assisted by others both in the larval and egg stages. The infestations receded somewhat in nearly all areas during 1926 and natural enemies were no doubt largely

PARASITES OF

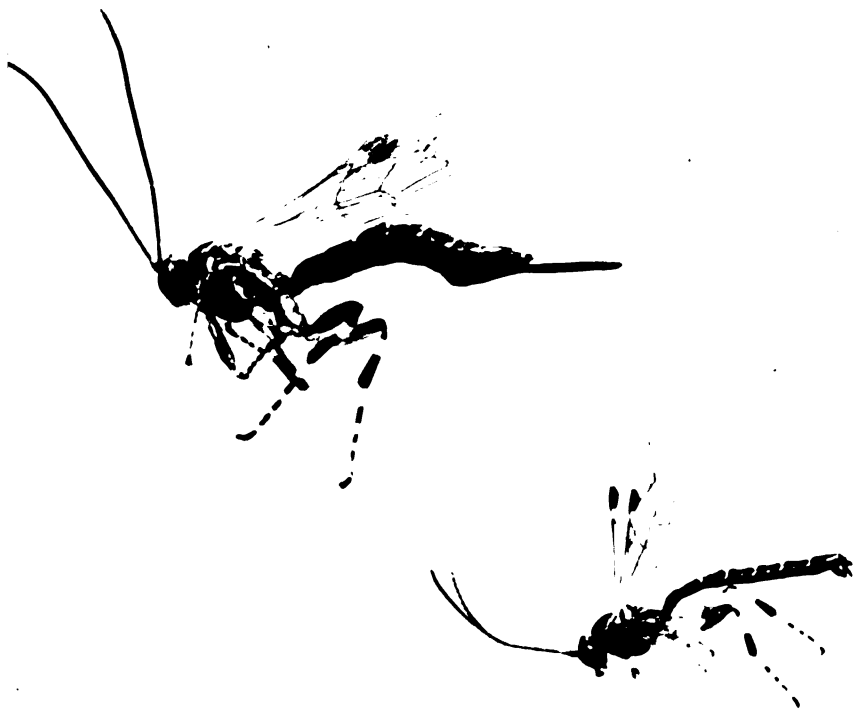
Ellopia fiscellaria

Amblyteles velox

Amblyteles puerilis

PARASITES OF

Ellopia fiscellaria



Itoplectes conquisitor

Female

Male

responsible for the decrease in the numbers of the worms. The over winter mortality whether due to parasites, predators, or other natural forces, was great and it is reasonable to suppose that egg parasites played an important part, although we did not find any of them.

No birds or predacious insects have been observed preying on the larvae.

Control -

Basing judgment on the experience of one season's observation and study of this insect, it would appear that natural means of control must suffice since artificial methods of dusting or spraying used on full-grown forest-trees would prove too expensive to be practical.

To be sure, airplane dusting would undoubtedly prove effective but the great cost of carrying on extensive operations of this nature would surely deter the owners of the land from trying it out except perhaps in an experimental way. Hemlock as a timber tree is of comparatively low value.

It is therefore encouraging to note the tendency toward a return to a natural balance which is being brought by the natural enemies of the pest.

During 1926 the attack receded and although considerable loss of timber value was involved in stands of well matured growth, the value of the "reproduction" does not warrant its protection by intensive control practice. No artificial measures were applied in Michigan in forest areas, although airplane dusting was considered, as was also widespread spraying with arsenical poisons, providing the infestation and probable damage seemed to warrant the expenditure.

In view of possible subsequent outbreaks, it is advisable to avoid wherever possible, pure stands of either hemlock or balsam.

Wherever trees of these preferred species are growing and are valued from an aesthetic standpoint, more intensive measures are often warranted. Arsenical sprays were applied at Leeland during the summer of 1925, and although the season was well advanced at the time of application, the results were quite marked. A general decrease in the number of pupae to be found occurred in the sprayed area, and later in the flight of moths. The pupae were very scarce and the moths almost unnoticeable.

Sprayed trees were still alive in this area during 1926 though nearly all of the unsprayed trees were dead or in very poor condition. Some few trees were partially covered by the spray and protected only

in part. The sprayed limbs were thrifty in comparison to stripped and dead branches which were not reached by the poison of the first application.

No dusting was done in Michigan to the writer's knowledge, but S. B. Fracker, State Entomologist of Wisconsin, reports a successful attempt at control by the use of dust distributed from airplanes. He also did some preliminary work with hand dusters, which resulted in gaining good control. Calcium arsenate dust was used and was applied without dilution at the rate of 20 pounds to the acre.

As a wet spray, a mixture of two to three pounds of arsenate of lead to one hundred gallons of water will prove satisfactory, providing the trees are drenched.

In conclusion, it would appear that artificial means seem to be warranted only in the case of especially valuable trees or in such areas as have an aesthetic value in addition to their potentialities as forest growth. This is true at least where hemlock and balsam are the species endangered. Where it is desirable to apply intensive measures, arsenical dusts or sprays are to be recommended. They should be applied early in the season, as soon as the worms appear, and may be repeated after an interval of ten to fourteen days if the infestation warrants the expenditure.

SUMMARY

To summarize the writer's observations on the species Ellopia fiscellaria and its activities in Michigan, it may be said that the recent outbreak was one of the periodic outbreaks of a native insect such as may be expected from almost any such insect. The appearance of the species Ellopia athasaria Walk, in large numbers in Ohio is accounted for by J.S.Houser* in this way. He reminds us further that, due to these potential powers of destruction, all insects which feed on leaves or animals, may be looked upon with suspicion.

The particular species under consideration spends a great part of its life in the egg state, this being the over-winter state. In the spring the larvae hatch and feed on desirable foliage throughout the summer. Pupation occurs late in August and in early September the adult moths fly and lay eggs, starting a new generation which is inactive until the following spring.

The feeding habits of the species make possible its destruction by means of stomach poisons. Arsenicals properly applied may be used successfully when the value of the trees justifies their use.

*Jour. Econ. Ent., April 1927, Vol.20, p.301.

BIBLIOGRAPHY

Ellopia fiscellaria Guene and related species.

1890 - Packard, A.S. - 5th Rept. U.S. Ent. Com. pp.186-841.

1903 - Smith, John B. - Check List of the Lepidoptera of Boreal N.A., p.79.

1909 - Swete, L.W. - Psyche. #16, Aug., p.96.

1925 - Fracker, S.B. - Jour. Econ. Ent., Vol.18, No.6, Dec. 1925.

1926 - Dibble, C.B. - Mich. Agr. Exp. Sta. Quar. Bul., Vol.8, No.3, Feb.1926. Also Circular Reprint.

1926 - Dibble, C.B. - U.S.D.A. Exp. Sta. Rec., Vol.55, No.1, p.54, July, 1926.

1927 - Fracker, S.B. - Jour. Econ. Ent., Vol.20, No.2, April 1927, p.287-295.

1927 - Houser, J.S. - Jour. Econ. Ent., Vol.20, No.2, April 1927, p.299-301.

ROOM USE ONLY