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JOHN M. CLARKE Director

EPHRAIM PORTER FELT State Entomologist

Bulletin 103

ENTOMOLOGY 25

THE GIPSY AND BROWN TAIL MOTHS

BY

EPHRAIM PORTER FELT D. Sc.

TRAM BUREAU OF
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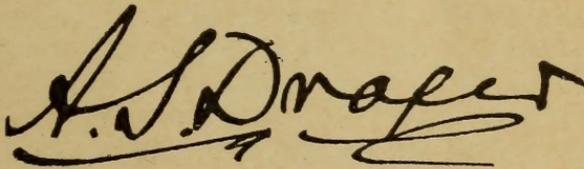
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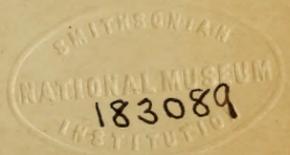
SIR: I beg to transmit herewith, for publication as a bulletin of the State Museum, a brief manuscript treating of the gipsy and brown tail moths. It seems advisable, in view of the great danger of these insects being brought into this State, that information relating to them should be made immediately accessible to the people.

Respectfully yours
JOHN M. CLARKE
Director

Approved for publication, February 16, 1906



Commissioner of Education





New York State Museum

JOHN M. CLARKE Director
EPHRAIM PORTER FELT State Entomologist

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ENTOMOLOGY 25

THE GYPSY AND BROWN TAIL MOTHS

BY

EPHRAIM PORTER FELT D. Sc.

These two ravenous leaf feeders, as it is well known, are thoroughly established in eastern Massachusetts and have amply demonstrated their pernicious natures. The gypsy moth caterpillar, remarkable because of its omnivorous tastes and voracity, is an exceedingly injurious form. It feeds, when present in large numbers, on almost every tree and shrub besides herbaceous plants. Its operations are particularly fatal to pine, hemlocks and other evergreens, since one defoliation of these trees is inevitably followed by death. Three strippings in successive years kill our more common deciduous trees such as oaks, maples, elms etc. It is difficult for one not conversant with the situation to gain an adequate idea of conditions in the infested region. Thousands of acres of deciduous trees have been killed as a result of the work of this insect. For example, one 40 acre woodland park was entirely defoliated in 1905. One tree in this infested tract was banded so that the insects could not ascend, and three wheelbarrow loads of caterpillars were removed from around its base. This gives a little idea of the hordes present in badly infested territory.

The more recently imported brown tail moth is especially destructive to fruit trees and has a marked fondness for wild cherry, white oaks, maples and elms. It has become so numerous in many sections of eastern Massachusetts as to strip thousands of these trees, and it has proved itself an efficient ally of the gypsy moth in the work of destruction. The ravages of these insects have become so serious that in some places owners of woodlands, rather than undertake the enormously expensive work of checking the pests, have sacrificed their forests to the woodman's axe, even within a few miles of the city of Boston.

It will be seen at once that these insects have inflicted serious financial loss in the infested sections and in addition thereto there has been great personal discomfort accompanied in some instances by physical suffering. The young caterpillars, easily dislodged during active feeding, spin down on a web when somewhat disturbed and adhere to the clothing of passers. This annoyance is very great and many carry umbrellas for the purpose of keeping the hairy pests at a little distance. The hordes of caterpillars living in adjacent forest or fruit trees desert the same when nearly mature or after their food supply is exhausted, and wander in all directions. They frequently become so abundant in localities where no effort has been made to check them, as to swarm on the sides of houses, literally covering square yards of buildings, and unless removed are very likely to make their way into the dwellings, to the horror of the housewife. Residents of the infested section during caterpillar time may be observed both morning and evening with brush and dustpan, removing the invaders from the buildings. The sidewalks become so thickly covered with the creatures that it is almost impossible to walk without crushing them, and the mangled remains of victims make footing very disagreeable if not insecure.

Worse than this, the stiff hairs of the brown tail moth caterpillar are barbed and, falling from their bodies or blowing from the empty cocoons in midsummer, may cause a very annoying rash, the brown tail itch, which is said by some to cause more suffering than that accompanying ivy or dogwood poisoning, the sting of bees or hornets, or other similar painful injuries. This irritation is so great in the case of persons with a somewhat delicate cuticle, as to cause serious illness. The trouble is so prevalent that salves or emollients for its allayment are for sale by most local druggists. It has been estimated that the rental value of property in the worst infested sections about Boston has been reduced from 20% to 50% on account of the caterpillar plague. Furthermore, the better class of people obliged to live in such districts, go to the country or seashore as soon as possible in the spring, and remain there till after the caterpillar season has passed, thus depriving the community of money which would otherwise be spent in infested districts.

The female gipsy moth does not fly and, unaided, the pest spreads slowly. The spinning down habits of the caterpillars facilitate its distribution by persons and vehicles, among the most efficient of which may be mentioned automobiles. The brown tail moth flies readily and has already extended its range greatly

There is grave danger of both of these insects being brought into New York State at almost any time, and the following brief descriptive accounts have been prepared so that our citizens may be able to recognize these two species upon their appearance in any locality.

Gipsy moth

Porthetria dispar Linn.

This notorious pest, widely and thoroughly established in eastern Massachusetts, has been known by reputation to residents of New York State for some years. The caterpillars are exceedingly voracious feeders, readily devouring the foliage of most trees and shrubs. There was practically no attempt made to control the gipsy moth in Massachusetts from 1900 to 1905 and as a consequence, its range has become greatly extended. According to Superintendent Kirkland, the pest has been found in 120 cities and towns and the infested area in Massachusetts is over 2000 square miles, nearly six times as great as that at the time work against this insect ceased. It has made its way nearly 30 miles west, occurring in such outlying towns and cities as Maynard, Stowe and Marlboro. A recent communication from Prof. E. D. Sanderson of Durham informs us that the pest has been found in southeastern New Hampshire, and the presence of a colony in Providence, R. I. has been known for some years. This pest has also become established at Stonington, Ct.

Destructiveness. It is very difficult for one not conversant with the situation to appreciate the destructiveness of this pest, which is greatly increased by its omnivorous nature. Its injuries are further emphasized by the gregarious habits of the caterpillars and the female's inability to fly. The result is that caterpillars abound upon individual trees, groups of trees or in extended woodland areas, and if not abundant enough to defoliate the trees one season, attain maturity and the parent insects deposit thousands of egg masses which another summer may produce millions of caterpillars that will entirely strip the foliage from infested sections and, spreading to adjacent fields, continue the work of destruction. The operations of this insect are particularly fatal to pines, hemlocks and other evergreens, since one defoliation of these trees is followed by death. The first serious outbreak in Massachusetts in 1889 and following years was comparatively limited though the injury in infested sections was severe. The

depredations of this caterpillar have been much extended in recent years, owing to the cessation of active control methods on the part of the state in 1900. The result is that many fruit, ornamental and shade trees have been seriously injured and the damage has been especially severe in the vicinity of infested woodlands. The cost of fighting the pest on unimproved lands is so great as to be beyond the means of the average individual. Those unfortunate enough to live in the vicinity of infested woods are not only obliged to control the caterpillars upon their own grounds, but are frequently seriously discommoded by those swarming on their premises from adjacent defoliated woodlands [pl. 3, 4]. A partial investigation in September of this year showed that large areas were very seriously infested by the caterpillars of both the gipsy and brown tail moths. Dead pines were familiar objects in infested woodlands and in not a few instances considerable forest areas were conspicuous because of the dead standing timber, mostly deciduous trees, which had been repeatedly defoliated by these voracious pests.

Danger of spreading into New York. The greatly increased area occupied by the gipsy moth, coupled with its excessive abundance in a number of localities, has materially increased the danger of this pest being brought into New York State. The known spread, as previously pointed out, is somewhat slow, it having made its way west only about 25 or 30 miles, and its northward extension is presumably about the same. Fortunately the female gipsy moth does not fly and as a consequence the spread of this species is slow, because it must rely for dissemination upon the ability of the caterpillars to crawl, their being carried by other agents, and the distribution of eggs. These latter are deposited on almost any object and have even been found on freight cars, so that no one can predict where this species may appear within the next few years. Freight cars are not, in our opinion, such dangerous carriers of this insect as some other agencies, because it is only occasionally that they stand in the vicinity of adequate food for the caterpillars, a necessity at the time the eggs hatch if the young are to survive. Street cars, automobiles, carriages and even individuals may serve as carriers. The street cars are restricted to comparatively narrow limits, which is not true of automobiles. These latter, during caterpillar time, may easily make a run of 100 miles from a badly infested section, carrying about the vehicle several caterpillars, which are thus readily established in the new location. The possibilities of spread in this manner are very great and numbers of these vehicles undoubtedly make long runs either through or from

the infested section. It is only necessary to cite in this connection an instance which illustrates what might take place. An acquaintance stated that on returning to New York city last summer from a visit to the infested region during caterpillar time, he brushed from his person a gipsy moth larva which, it is needless to add, was promptly destroyed. There is no guaranty that others were not brought and it is somewhat disquieting to think of the possibilities in the case of others proceeding directly from infested areas to localities where this pest is still unknown.

The insect can be conveyed long distances in the egg and it is rather surprising that such has not occurred more frequently. Any hard object remaining near an infested tree during July, while oviposition is in progress, is very likely to bear one or more clusters of eggs. There is great danger of the pest being carried with household effects to most distant points, specially if packed in boxes and barrels which have been allowed to lie where the females could deposit eggs upon them. The danger of the insect being spread in this way is, in our opinion, much greater than of its being carried by egg masses deposited on freight cars as mentioned above.

Description. The great danger of this insect being brought into New York State makes it advisable for all to be on the lookout for this pest, and for this reason we have prepared a rather careful notice of the species, giving particular attention to descriptive details in order that the insect may be recognized and checked before it has caused serious injuries. We further counsel great moderation on the part of amateurs in attempting to identify this species. A false statement regarding its occurrence may cause serious injury to local interests, whereas the delay of a few days necessary to secure an authentic determination will ordinarily be of but little moment.

The eggs of this insect, occurring from midsummer to the following spring, appear very much like a small section of sponge. They are deposited usually in round or oval masses [pl. 1, fig. 8; pl. 7] on a piece of bark and then covered with buff colored scales from the underside of the female's abdomen. These egg masses may be found on stones, in tin cans and in fact on almost any stationary object near at hand, not excluding plantain leaves and other vegetation. They are particularly likely to occur on the undersurface of limbs, fence rails, moldings, cornices etc., on houses. The nearly globular, pale yellowish or salmon-colored eggs are about $\frac{1}{16}$ inch in diameter [pl. 1, fig. 9, 10] and there are usually 400 to 500 in a cluster, though occasionally 1000 may be found in an egg mass.

The young caterpillar is slightly over $\frac{1}{10}$ inch long just after it emerges from the egg. It has a black head, the body is brownish yellow and well clothed with long hairs. There is a prominent hairy tubercle on either side of the segment next the head, which gives the caterpillar a peculiar broad-headed appearance in its early stages. The markings become plainer as it increases in size and when full grown it is from 2 to $2\frac{1}{2}$ inches long. The caterpillar then has a double row of conspicuous warts or tubercles down its back, the eight anterior, not counting the four blue ones just behind the head blue, the 12 remaining red. Similar tubercles occur on the side. Two nearly full grown caterpillars are represented on plate 1, figures 6, 7. These caterpillars, like the well known forest tent caterpillar, *Malacosoma disstria* Hüb., assemble in masses on the trunks [pl. 5] and underside of limbs, sometimes covering large areas.

The somewhat conical, dark brown pupa [pl. 1, fig. 5], ranges from $\frac{3}{4}$ to $1\frac{1}{2}$ inches long and is usually found in numbers [pl. 6] lying among a few threads and securely attached to them by its terminal spine.

The male and female moths differ widely. The former is a slender, olive-brown, black marked insect with featherlike antennae and has a wing spread of about $1\frac{1}{2}$ inches. It is represented with wings expanded at figure 3 and in a resting position at figure 4 on plate 1. It flies in the late afternoon and early evening. The female is much heavier and lighter colored. She has a wing spread of about 2 inches and is white or buff-white with more or less distinct black markings. The abdomen is tipped with black. She is represented with the wings spread and in the characteristic resting position at figures 1 and 2 respectively, on plate 1 and on plate 7. The female moth does not fly though she apparently has well developed wings.

History in America. This pest was introduced into Medford, Mass. in 1868 or 1869 and, escaping from its introducer, attracted little notice for about 10 years. Then the caterpillars became somewhat abundant and in 1889 Medford and vicinity were literally overrun with the pests, the infestation bordering closely on a plague. An act, passed in the winter of 1890, provided for the appointment of a special commission and placed at its disposal \$25,000, which sum was subsequently increased by an equal amount. An appropriation of \$50,000 was made in 1891 and from then to 1899, appropriations ranged from \$75,000 to \$190,000 annually. The total amount expended by the commonwealth of Massachusetts

during a decade, amounted to \$1,155,000. The work was so successful that in many sections badly infested in 1890, gipsy moth caterpillars were remarkable for their scarcity in 1898 and following years. Residents of the infested sections almost forgot that there had ever been such a pest, and made light of the close exterminative methods then in vogue. Unfortunately the work was abandoned at this stage and the insect has had an opportunity of multiplying almost without restriction during the past five years, greatly extending its range and causing serious depredations as described in a previous paragraph.

Life history. The winter is passed in an egg mass remarkably resistant to atmospheric and other changes. Experiments have shown that even when egg clusters were broken up and freely exposed to the elements, their contents were apparently unharmed and a normal proportion of caterpillars appeared at the usual time, which, in the vicinity of Boston, is from the last of April to the middle of June. The feeding period extends from the first of May to about the middle of July, the caterpillar requiring from about 9 to 11 weeks to complete its growth and enter the pupal stage. The recently hatched caterpillars remain on the egg clusters from one to five or more days and then commence feeding on the leaf hairs. Soon they eat out small holes in the foliage and after the third or fourth molt about as many feed on the edge of the leaf as eat out holes. The caterpillars are largely nocturnal, remaining in clusters on limb or trunk or hiding in some crevice during the day, beginning between 7 and 8 o'clock in the evening leisurely to ascend the tree, where they feed on the foliage at intervals during the night, descending about 3 o'clock in the morning. The gipsy moth caterpillars assemble in just such masses as those formed by our native forest tent caterpillar, *Malacosoma discoria* Hübn., so abundant in sections of New York State about 1900. This imported species is just as destructive as our native form and much more dangerous because of its feeding upon a large variety of plants.

The caterpillars transform to pupae during the month of June, moths appearing from the latter part of June to the latter part of July, and belated individuals may even be found in September. Males emerge in advance of the opposite sex and shortly after females appear, pairing takes place and eggs are laid. The embryos or very young caterpillars are frequently well developed within the eggs in two or three weeks after oviposition and as a rule they do not emerge till the next spring. One case is on record of

eggs hatching in early September 1895, at Woburn, Mass., but the round of life was not completed and in this northern latitude there need be little fear of two generations annually.

Food plants. These caterpillars are quite destructive because of the very large number of plants on which they can thrive. They will eat, without hesitation, almost all our native shrubs and trees, and when hard pushed can subsist for a time at least on a number of herbaceous plants. The common fruit trees, the elms, maples and oaks are all eaten readily and even with the list no greater, the pest would be a most serious one to control. It is particularly destructive to pine, hemlock and other evergreen trees because a single defoliation destroys them. It feeds on many other plants, as the list of 536 species given in the exhaustive report of 1896 on this insect attests. It is true that the caterpillar feeds on some of these only when compelled by starvation and that it can not be considered an enemy of a number of others, but after making most liberal allowance for these, the list is still a very formidable one.

Natural enemies. This insect has a number of natural enemies in this country, though unfortunately none of them are aggressive enough to warrant placing much dependence on them. They should, however, be encouraged by all possible means. About a dozen native song birds, as recorded by Mr Forbush, are very useful in devouring one stage or another of this moth, and about 29 other species feed on it to a slight extent or more largely when their usual food supply is somewhat scarce. The most useful birds are the yellow and black billed cuckoos, Baltimore oriole, cat-bird, chickadee, blue jay, chipping sparrow, robin, red-eyed and yellow-throated vireos and crow.

A number of predaceous and parasitic insects have either been reared from this species or observed preying on it, but none of them are of sufficient importance to warrant special mention in this connection. A determined effort is being made by Superintendent Kirkland in cooperation with Dr Howard of the Federal Bureau of Entomology, to bring into this country natural enemies of this very destructive pest, in the hope that some forms will prove of considerable value in keeping this leaf feeder in subjection. Nothing can be promised in the way of results, yet this line of effort is sufficiently promising to warrant its being followed so far as possible.

Recommendations. Investigate anything that arouses a suspicion that it may be the gipsy moth, but be in no undue haste to identify the insect. There have already been some false alarms

occasioned by persons with more enthusiasm than discretion, who have attempted to identify an insect with which they are unfamiliar. It is much more satisfactory to submit the specimens to an entomologist than to arouse unnecessary fears.

It would undoubtedly pay to exterminate a small colony, but in the course of time this will be impractical. We must learn to control it on our own land. The inability of the female to fly and the conspicuous character of the egg masses make this task relatively easy upon cultivated land. The private individual can hardly cope with this insect in forest lands. The point of establishment in this State is almost bound to be near some dwelling and therefore the species need not be allowed to establish itself in wild lands at least for some years, and by that time it is most sincerely hoped that some adequate check, natural or otherwise, may be found which can be employed to advantage in forest lands.

The larva is quite resistant to arsenical poisons and it requires a large dose to kill it, specially when the caterpillar is nearly grown. There is probably no better poison for this insect than arsenate of lead, using at least 5 pounds to 50 gallons. The application should be made as soon as the young leaves are well grown in order to destroy the caterpillars if possible while they are young and therefore most susceptible to the insecticide. Ordinarily thorough and timely spraying with an arsenical poison should be sufficient to keep this pest in subjection on fruit and shade trees.

One of the most effective methods of keeping this pest under control is by the destruction of the egg masses. Creosote oil applied to the egg mass will soak in and kill the eggs. The following preparation has been extensively used in work against the gipsy moth. Creosote oil 50%, carbolic acid 20%, spirits of turpentine 20%, and 10% of coal tar. The latter is added to color the compound and thus show at a glance what clusters have been treated. It is usually best for two men to work together, one standing upon the ground to point out the egg clusters and the other applying the mixture. No ordinary fire running over the ground can be relied upon to kill egg masses attached to stumps, foliage, stones or similar places. They must either be removed and burned in a stove or furnace or touched with the creosote oil preparation as described above.

The caterpillars prefer to hide during the daytime. Advantage may be taken of this habit by tying burlap bands in the middle around the tree trunks and dropping the upper portion of the burlap down over the string. The bands can be lifted daily and the

caterpillars assembled beneath killed. This method proved of so great value in the exterminative work against the gipsy moth, that thousands of trees were banded during the latter part of the caterpillar season. The trouble with the two last named methods is that they are quite expensive though very efficient, and on that account their employment will be restricted largely to shade trees and ornamentals in parks, where expense is a question of minor importance.

Bibliography

A few only of the more important and valuable works relating to this insect are cited. The first named, by Messrs Forbush and Fernald, is by far the most comprehensive volume and includes everything of value relating to this insect up to the time of its publication.

1896 **Forbush, E. H. & Fernald, C. H.** The Gypsy Moth. (A report of the work of destroying the insect by the commonwealth of Massachusetts, together with an account of its history and habits both in Massachusetts and Europe, p.495 + 100)

1901 **Felt, E. P.** N. Y. State Entomologist, 16th Report 1900, p.955-62. (A summary account)

1905 **Kirkland, A. H.** The Gypsy and Brown Tail Moths. Office of the Superintendent for Suppressing the Gypsy and Brown Tail Moths, Bul. 1, p.1-27. (A summary account of both insects)

Brown tail moth

Euproctis chrysorrhoea Linn.

This species, a more recent introduction than the gipsy moth, has already attained a much wider distribution and promises to develop into a serious pest of fruit, shade and certain forest trees. It will prove exceedingly difficult to control this pest in forest areas if it becomes at all abundant and destructive. This insect is not only injurious to the foliage of trees, but the barbed hairs of the caterpillar, falling upon human flesh, may produce a severe and occasionally dangerous irritation. This latter phase of the trouble has been so serious as to cause the board of health of the city of Boston to give a public hearing on the subject in 1901.

Destructiveness. The caterpillars are very voracious, feeding by preference on the foliage of both apple and pear [pl. 8, 9], wild cherry and white oak, though they thrive on both soft and hard maples and also elm. They are exceedingly abundant in the Middlesex Fells and other extensive wooded areas north or north-west of Boston, and last spring defoliated large tracts of white

oaks. The numerous nests of young caterpillars, visible in these wooded sections last September, gave every indication that the injuries next season would be more extensive than were those during the spring of 1905. The nests of this insect were very abundant on hard and soft maples in and about Saugus and there is every probability that unless active steps are taken these trees will be defoliated another year. The nests were less apparent on the elm. Numerous apple and pear trees throughout the infested region were in a dead or dying condition and bore striking testimony to the voracity of this insect, while others supported many nests containing caterpillars destined to continue the work of devastation another season.

The serious effects upon property values, caused by the abundance of gipsy moth caterpillars, applies with double force to those of this pest, since the caterpillars are not only extremely annoying when abundant, but their irritating barbed hairs, blowing from the nests or cocoons, are constant reminders of the insect's presence aside from the serious discomfort inflicted.

Distribution. This species, unlike the gipsy moth, spreads readily with the wind, as the female moths fly without difficulty. This has been an important factor in extending the distribution of the insect. It was brought into this country in the early 90's and in 1901 it had made its way 30 miles west to Hudson, Mass. It has been reported from the Connecticut valley, has spread half or two thirds the length of the state of New Hampshire, occurs at Kittery, Me., and has been found at St John, New Brunswick.

Brown tail moth caterpillars, like those of the gipsy moth, may be carried considerable distances on vehicles or persons, though favorable winds at the time the moths fly seem to be the most important factor in distributing the pest. There is some danger that automobiles passing through infested sections during the time the moths are in flight may carry gravid females long distances and correspondingly hasten the spread of the insect. One of the agents connected with the work of suppressing this pest and the gipsy moth states that a considerable number of moths were found last summer among the cushions of an automobile in the infested section. The long runs made by these vehicles render it very possible that uninjured adults have been carried beyond the limits of the present known infested area. These facts indicate a strong probability of this pest becoming established shortly within the bounds of New York State, if it has not already obtained a foothold.

Description. The male moths have a wing spread of about $1\frac{1}{4}$ inches, are pure white with a satiny luster on the fore wings and have a conspicuous reddish brown tuft at the tip of the abdomen [pl. 2, fig. 5, 6]. Sometimes there are a few black spots on the fore wings. The antennae are white and fringed with pale yellowish hairs. The females are the same size and color as the males except that they have no black spots on the wings and the anal tuft is larger and blacker in color while the antennae are shorter and with shorter fringes.

The eggs, laid in July in masses of 200 to 300, are usually placed on the underside of the leaves [pl. 2, fig. 1], where they are covered with brown hairs from the tip of the abdomen. They hatch in a short time and the young feed during the rest of the season on the surface of the leaves, a few days only being required to skeletonize them. The caterpillars begin at once to make a nest [pl. 2, fig. 7] in which they hibernate while still young. It is constructed on the twigs and is made by drawing together a few leaves, lining them with silk and inclosing them with a mass of silken threads [pl. 10]. These tents are so firmly secured to the twigs that they can be removed only with considerable force.

The young or overwintering caterpillar is easily recognized by its black head, dark color and particularly, by the two conspicuous tufts on the anterior two abdominal segments, and the two circular papillate reddish elevations on the dorsum of the sixth and seventh segments. The hibernating caterpillars are found in silk-lined pockets within dense firm webs, which are torn open with difficulty.

Hibernating larva. It is sparsely clothed with long, brownish, barbed hairs, about $\frac{1}{4}$ inch long, and with the head and body dark brown or black. There are two conspicuous reddish dorsal tufts on the first and second abdominal segments, rather pale, median, sublateral, reddish lines on the dorsum of third, fourth and fifth abdominal segments and a conspicuous, oval, reddish, tubercular process on the dorsum each of the seventh and eighth abdominal segments. Labrum pale whitish. The anterior margin of the thoracic shield with a pair of sublateral, oval, pale orange markings, and with a large, paler, lateral tubercle below. The second and third thoracic segments are thickly studded with black tipped tubercles, the sides and intervening space being pale yellowish. There is a sublateral line of pale yellowish white, the dorsal margin of a row of conspicuous lateral tubercles, each bearing a spreading fascicle of long hairs. There is a stigmatal row of large, dark brown tubercles lying in a broad band of pale yellowish white. The true legs are dark brown, the prolegs brown with golden-yellow tips.

The full grown caterpillars [pl. 2, fig. 3], range from 1 inch to $1\frac{1}{4}$ inches long. The pale brown head is mottled with dark brown and has reddish brown hairs scattered over its surface. The body is dark brown or black with numerous fine, dull orange or gray spots over the surface, which are most pronounced on the second, third and fourth segments. Long, reddish brown, finely barbed hairs arise from all the tubercles, and white branching hairs from the upper side of the lateral tubercles on segments 4 to 12 inclusive. These white hairs form elongated white spots along each side and are one of the most striking characteristics of the full grown caterpillar. The subdorsal and lateral tubercles on segments 4 to 12 inclusive are covered with fine, short spines of uniform length. The bright red retractile tubercles on the top of the 10th and 11th segments are also visible as described above.

The pupa is $\frac{3}{4}$ inch long, dark brown in color and with fine, yellowish brown hairs [pl. 2, fig. 4] scattered over the surface.

The close, firm webs [pl. 2, fig. 7; pl. 10] of this species are also very characteristic. They are 4 to 6 inches long and occur on the tips of the smaller twigs, remaining there throughout the winter.

Life history. The winter is passed by partly grown caterpillars in the peculiar webs on the terminal twigs. They begin work in the spring, feeding downward from the tip of the branches, leaving the naked twigs and the gray apex at their extremities, conspicuous evidence of their presence. All the leaf but the midrib is devoured except that in the case of trees like the sycamore maple, the larger ribs also are untouched. The caterpillars when numerous attack not only buds, leaves and blossoms, but even green fruit. They are gregarious till nearly full grown, when they disperse to some extent, and this spreading is more marked when the food supply on the tree becomes exhausted. Several caterpillars frequently pupate in a common cocoon within the leaves at the tip of the branches and sometimes in masses under fences, clapboards or on the trunks and larger branches of trees. The webs of the brown tail moth may be easily distinguished from those of the tent caterpillar, *Malacosoma americana* Fabr., or the fall webworm, *Hyphantria textor* Harr., both common native species, since the tent caterpillar makes its web in the forks of the branches, whereas those of the brown tail moth occur at the tips. The fall webworm rarely attacks pear or hard maple, both of which are more or less favorites of the brown tail moth. The former makes a much larger, more open web than the latter. Moreover it is never firmly attached to the twig

by bands of silk as is the case with this introduced species. The snow-white brown tail moths are attracted to light and in infested regions may be very numerous in July.

Food plants. This species has been recorded on a considerable number of food plants. Apple and pear appear to be favorites in the infested region, and the same is true of wild cherry and white oak. The pests are nearly as abundant on both hard and soft maples and apparently to a less extent on elm. It also occurs on quince, plum, cherry, peach, rose and grape, some of which are seriously injured. Messrs Fernald and Kirkland give a list of 81 trees and shrubs upon which the caterpillars have been observed feeding.

Irritation caused by the hairs. Investigations have shown that this trouble is entirely a mechanical one and is not, as it was at first supposed, due to any poisonous irritating substance in the hairs. The nettling of the skin may be caused by contact with either old or young caterpillars or cocoons, though in the latter case contact is not necessary, since hairs from them are blown about by the winds. Professor Fernald cites the statement of an English journal that travelers are often affected when the wind blows strongly from infested hedges along the road. This severe irritation may be allayed by applying vaseline and sweet oil to the affected parts. Alcohol has been employed with some success, and the trouble is so prevalent in the Metropolitan district that druggists have special lotions for this brown tail itch, many of which are valuable.

Natural enemies. A number of parasites have been reared from pupae in this country. Professor Fernald records the breeding of *Phaegogenes hebe* Cress., *Diglochis omnivora* Walker, *Euphorocera claripennis* Macq. and a large number of unnamed dipterous parasites from this insect. He states that the work of *Diglochis* is specially valuable and he also records the destruction of many caterpillars by the soldier bug, *Podisus serieventris* Uhl., *P. placidus* Uhl., *Milyas cinctus* Fabr. and *Liotropis humeralis* Uhl. assist in this good work. A serious effort is being made by Superintendent Kirkland to obtain European parasites of this species, and in view of its extended depredations upon forest trees it is most sincerely hoped that the quest will prove entirely satisfactory.

A number of native birds prey upon this species. Professor Fernald states that the Baltimore oriole, black-billed and yellow-billed cuckoos, crow, bluebird and English sparrow have also been

observed feeding on these insects, and quotes Mr Kirkland to the effect that the birds eat not only the moths, but their young. Messrs Fernald and Kirkland state that the notorious English sparrow has a strong redeeming trait in its fondness for the moths, it ranking as their most formidable bird enemy. In addition to the above mentioned birds, Mr E. H. Forbush has recorded the robin, blue jay, black and white warbler, the rose-breasted grosbeak, the chestnut-sided warbler, the scarlet tanager, redstart, chickadees, red-eyed vireos and yellow-throated vireos and the male indigo bird as feeding on the caterpillars. The blue jay and the yellow-throated vireo are specially valuable. The records given by Mr Forbush include the number of larvae eaten by each bird and the time occupied. None ate less than nine, and one as many as 57 caterpillars, the latter operation occupying 20 minutes. These observations show that our native birds will undoubtedly prove very efficient aids in checking this pest. Professor Fernald has also recorded bats as feeding on the moths at night, and he states that toads devour the caterpillars during the early summer and the moths later in the season.

Remedial measures. The conspicuous hibernating nests [pl. 2, fig. 7] of this species are easily detected at any time when the foliage is off the trees, and one of the most effective methods of checking this pest is to cut them off and burn them. This can be very easily done with the aid of long handled pruning shears and ladders. The insect is also readily controlled with arsenical poisons; and Professor Fernald reports experiments in spraying with arsenate of lead, in which 1 pound to 150 gallons killed 50% of the caterpillars in four days, 90% in seven days and all in 13 days. Treatment with the same insecticide, 2 pounds to 150 gallons, gave similar results, and when 5 pounds were used to 150 gallons 80% were dead within four days and all in nine days. The use of 10 pounds to 150 gallons resulted in the destruction of all the caterpillars in six days.

Spraying with paris green, 1 pound to 150 gallons, killed 4% in four days, 70% in six days and 90% in nine days, all being dead in 12 days.

The methods described above, while applicable to the more valued fruit and shade trees, can hardly be employed to advantage in forest areas. This species it is feared may become a serious pest in oak and maple timber unless natural enemies, either native or introduced, prevent its becoming unduly abundant. It is difficult at the present time to see how, with our present methods, it can be fought successfully in extensive forest areas.

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- 1903 **Fernald, C. H. & Kirkland, A. H.** The Brown Tail Moth. A Report on the Life History and Habits of the Brown Tail Moth, p.1-73. (A detailed account of this species in America and methods of controlling it)
- 1905 **Kirkland, A. H.** The Gypsy and Brown Tail Moths. Office of the Superintendent for Suppressing the Gypsy and Brown Tail Moths, Bul. 1, p.1-27. (Summarized account in connection with the gipsy moth)

EXPLANATION OF PLATES

PLATE 1¹

¹Reproduced through the courtesy of the secretary of the Massachusetts State Board of Agriculture.

Gipsy moth

Porthetria dispar Linn.

- 1 Female with wings expanded
- 2 Female in resting position
- 3 Male with wings expanded
- 4 Male in resting position
- 5 Pupa
- 6 Dorsal view of one of the larger caterpillars, presumably a female
- 7 Dorsal view of one of the smaller full grown caterpillars, presumably a male
- 8 Egg cluster on a piece of bark
- 9 A few eggs greatly enlarged
- 10 One egg still more enlarged



1.



2.



3.



4.



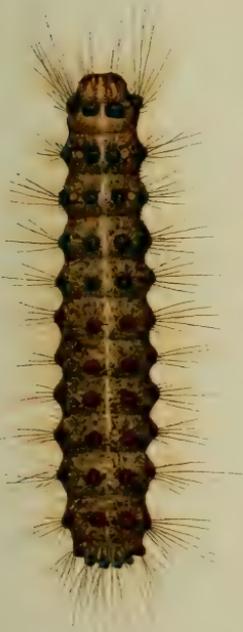
5.



10.



9.



6.



7.



8.

GIPSY MOTH

(After Massachusetts State Board of Agriculture)

PLATE 2¹

¹Executed from nature under the author's direction by L. H. Joutel, and reprinted from N. Y. State Mus. Bul. 64.

Brown tail moth

Euproctis chrysorrhoea Linn.

- 1 Egg mass on the underside of a pear leaf and also on twig
- 2 Young caterpillars or larvae as they appear in early spring
- 3 Half grown and full grown caterpillars
- 4 Pupae in portion of a web mass, also a few cast larval skins
- 5 Male moth at rest
- 6 Female moth with wings partly extended
- 7 Hibernating tents in which the winter is passed



Brown-tail moth

PLATE 3

Forest trees stripped by gipsy moth caterpillars. Malden, Mass., July 1905. From unpublished photograph loaned by Kirkland

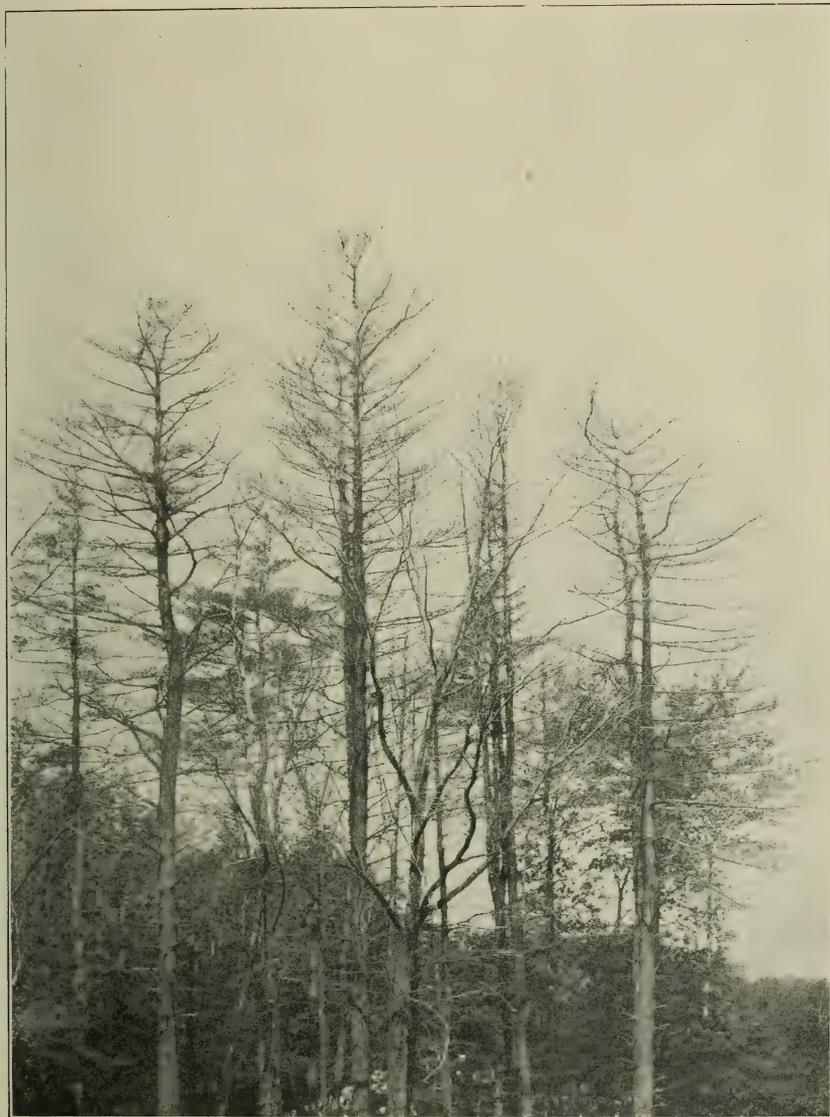


Work of gipsy moth caterpillars

PLATE 4

Pine and other trees attacked by gipsy moth caterpillars at Melrose, Mass. Photo June 1905. From unpublished photograph loaned by Kirkland

Plate 4

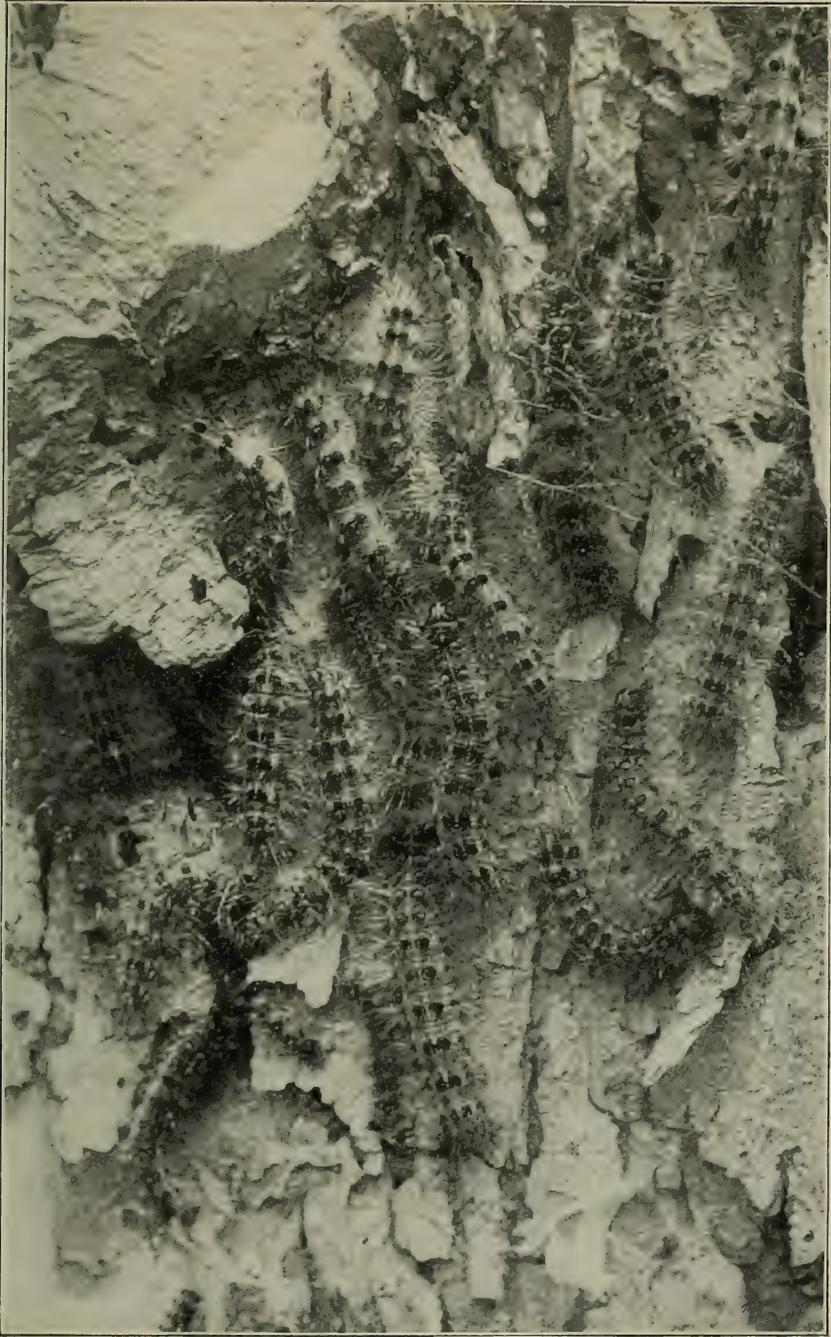


Pines killed by gipsy moth caterpillars

PLATE 5¹

¹Plates 5-7 reprinted from *The Gypsy Moth*, Mass. State Bd Agric. 1896.

Full grown gipsy moth caterpillars about to pupate on the trunk
of a walnut tree. Arlington, Mass., July 9, 1891



Cluster of gipsy moth caterpillars

PLATE 6

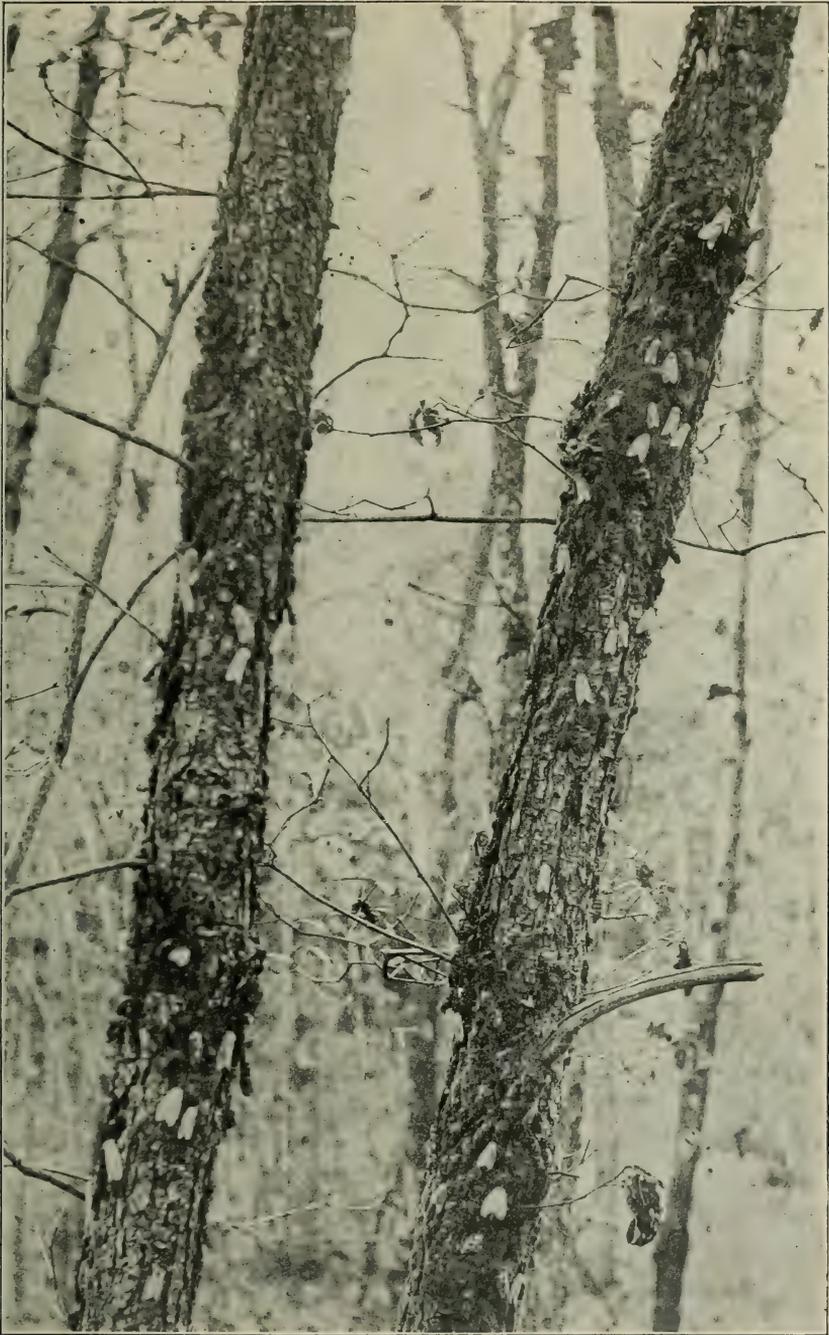
A large stone has been removed from the ledge, exposing a mass of gipsy moth pupae. Arlington, Mass., July 9, 1891



Masses of gipsy moth pupae

PLATE 7

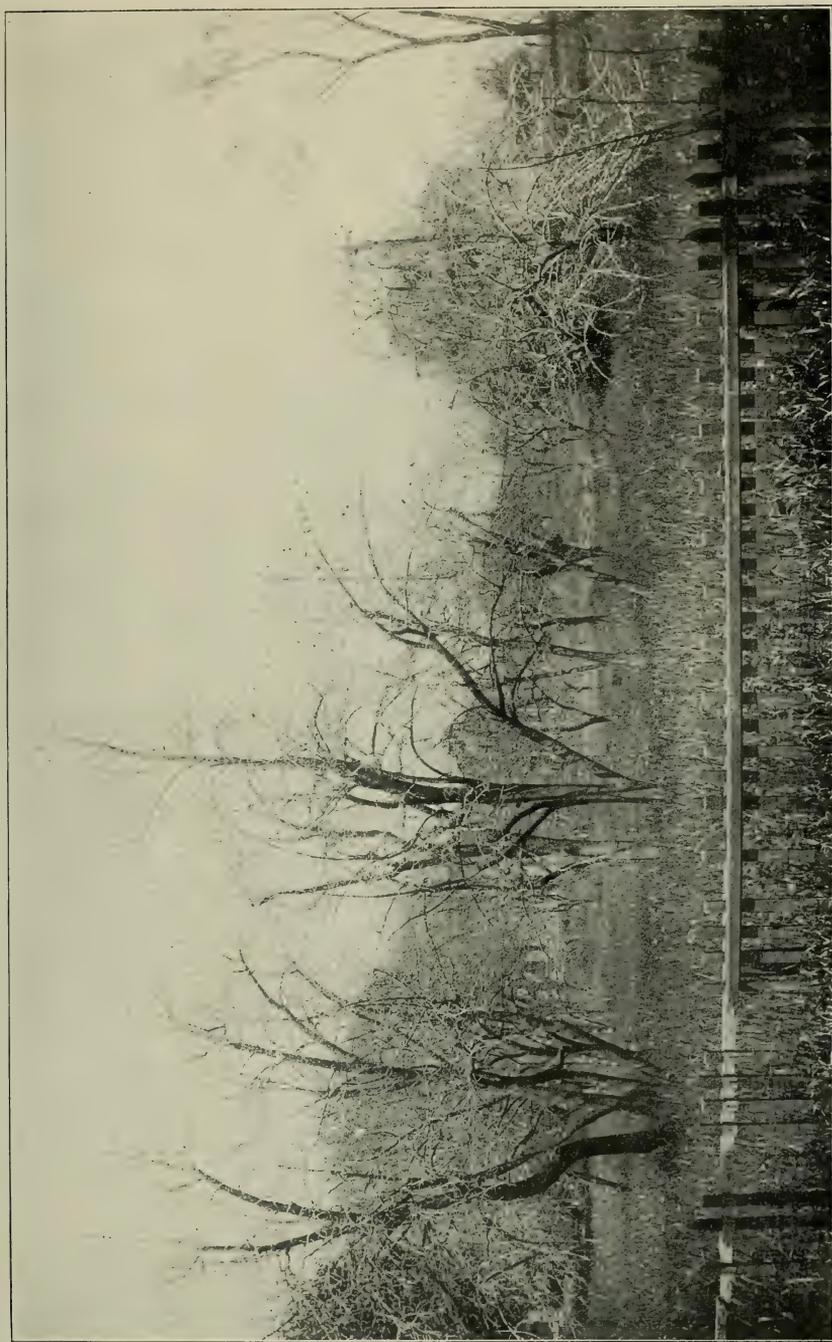
Female gipsy moths depositing egg clusters on the trunk of an
oak tree Saugus, Mass., 1895



Gipsy moths depositing eggs

PLATE 8

Peartree defoliated by brown tail moth caterpillars. The webs on the trees in the background were destroyed during the previous winter. Winchester, Mass. Photo June 9, 1905. From unpublished photograph loaned by Kirkland



Pear trees defoliated by brown tail moth caterpillars

PLATE 9

Web of brown tail moth caterpillars on pear. Melrose, Mass.,
March 1906. From unpublished photograph loaned by Kirk-
land

Plate 9

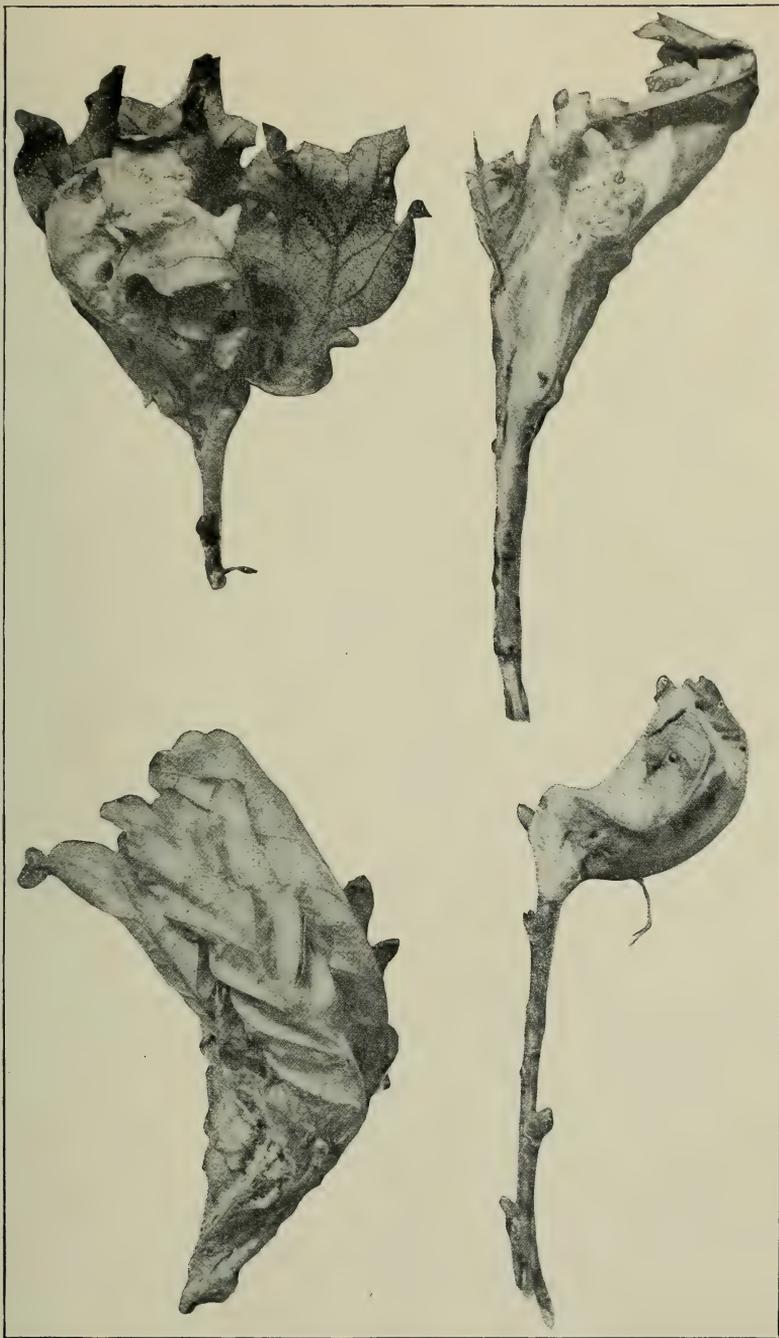


Webs of brown tail moth caterpillars

PLATE 10¹

¹Plate 10 reprinted from *The Brown Tail Moth*, Mass. State Bd Agric. 1903.

Winter webs of brown tail moth on English oak. Photo by
Charles Bradley, Sup't Farm School, Thompson's island



Winter webs of brown tail moth

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New York State Education Department

New York State Museum

JOHN M. CLARKE, Director

PUBLICATIONS

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Museum annual reports 1847-date. *All in print to 1892, 50c a volume, 75c in cloth; 1892-date, 75c, cloth.*

These reports are made up of the reports of the Director, Geologist, Paleontologist, Botanist and Entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Director's annual reports 1904-date.

These reports cover the reports of the State Geologist and of the State Paleontologist bound also with the museum reports of which they form a part.

Report for 1904. 138p. 20c. Report for 1905. 102p. 23pl. 30c.

Geologist's annual reports 1881-date. Rep'ts 1, 3-13, 17-date, O; 2, 14-16, Q.

In 1898 the paleontologic work of the State was made distinct from the geologic and was reported separately from 1899-1903. The two departments were reunited in 1904, and are now reported in the Director's report.

The annual reports of the original Natural History Survey, 1837-41, are out of print.

Reports 1-4, 1881-84, were published only in separate form. Of the 5th report 4 pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891) and 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	Price	Report	Price	Report	Price
12 (1892)	\$.50	17	\$.75	21	\$.40
14	.75	18	.75	22	.40
15, 2v.	2	19	.40	23	.45
16	1	20	.50		

[See Director's annual reports]

Paleontologist's annual reports 1899-date.

See first note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Those for 1901-3 were issued as bulletins. In 1904 combined with the Director's report.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882-date.

Reports 3-20 bound also with museum reports 40-46, 48-58 of which they form a part. Since 1898 these reports have been issued as bulletins. Reports 3-4, 17 are out of print, other reports with prices are:

Report	Price	Report	Price	Report	Price
1	\$.50	9	\$.25	15 (En 0)	\$.15
2	.30	10	.35	16 (" 10)	.25
3	.25	11	.25	17 (" 14)	.30
5	.15	12	.25	18 (" 17)	.20
7	.20	13	.10	19 (" 21)	.15
8	.25	14 (En 5)	.20	20 (" 24)	.40
				21	In press

Reports 2, 8-12 may also be obtained bound separately in cloth at 25c in addition to the price given above.

Botanist's annual reports 1867-date.

Bound also with museum reports 21-date of which they form a part; the first Botanist's report appeared in the 21st museum report and is numbered 21. Reports 21-24, 29, 31-41 were not published separately.

Separate reports for 1871-74, 1876, 1888-96 and 1898 (Botany 3) are out of print. Report for 1867 may be had for 40c; 1899 for 20c; 1900 for 50c. Since 1901 these reports have been issued as bulletins [see Bo 5-8].

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have also been published in volumes 1 and 3 of the 48th (1894) museum report and in volume 1 of the 49th (1895), 51st (1897), 52d (1898), 54th (1900), 55th (1901), 56th (1902), 57th (1903) and 58th (1904) reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and, combined with others more recently prepared, constitute Museum memoir 4.

NEW YORK STATE EDUCATION DEPARTMENT

Museum bulletins 1887-date. O. To advance subscribers, \$2 a year or \$1 a year for division (1) geology, economic geology, paleontology, mineralogy; 50c each for divisions (2) general zoology, archeology and miscellaneous, (3) botany, (4) entomology.

Bulletins are also found with the annual reports of the museum as follows:

Bulletin	Report	Bulletin	Report	Bulletin	Report	Bulletin	Report
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6	57, v. 1	Z 3	53, v. 1	20	" v. 1	8	57, v. 2
Eg 5, 6	48, v. 1	4	54, v. 1	21	" v. 1	"	9 v. 2
7	50, v. 1	5-7	" v. 3	22	" v. 1	Ms 1, 2	56, v. 4
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Pa 1	54, v. 1	10	54, v. 2	2	51, v. 1		

The figures in parenthesis in the following list indicate the bulletin's number as a New York State Museum bulletin.

- Geology. G1 (14) Kemp, J. F. Geology of Moriah and Westport Townships, Essex Co. N. Y., with notes on the iron mines. 38p. 7pl. 2 maps. Sep. 1895. 10c.
- G2 (19) Merrill, F. J. H. Guide to the Study of the Geological Collections of the New York State Museum. 162p. 119pl. map. Nov. 1898. [50c]
- G3 (21) Kemp, J. F. Geology of the Lake Placid Region. 24p. 1pl. map. Sep. 1898. 5c.
- G4 (48) Woodworth, J. B. Pleistocene Geology of Nassau County and Borough of Queens. 58p. il. 9pl. map. Dec. 1901. 25c.
- G5 (56) Merrill, F. J. H. Description of the State Geologic Map of 1901. 42p. 2 maps, tab. Oct. 1902. 10c.
- G6 (77) Cushing, H. P. Geology of the Vicinity of Little Falls, Herkimer Co. 98p. il. 15pl. 2 maps. Jan. 1905. 30c.
- G7 (83) Woodworth, J. B. Pleistocene Geology of the Mooers Quadrangle. 62p. 25pl. map. June 1905. 25c.
- G8 (84) — Ancient Water Levels of the Champlain and Hudson Valleys. 206p. 11pl. 18 maps. July 1905. 45c.
- G9 (95) Cushing, H. P. Geology of the Northern Adirondack Region. 188p. 15pl. 3 maps. Sep. 1905. 30c.
- G10 (96) Ogilvie, I. H. Geology of the Paradox Lake Quadrangle. 54p. il. 17pl. map. Dec. 1905. 30c.
- Woodworth, J. B. & Hartnagel, C. A. Miscellaneous Papers. Prepared.
- Contents: Woodworth, J. B. Postglacial Faults of Eastern New York.
Hartnagel, C. A. Stratigraphic Relations of the Oneida Conglomerate.
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- Fairchild, H. L. Glacial Waters in the Erie Basin. *In press.*
- Drumlins of New York. *In preparation.*
- Cushing, H. P. Geology of the Theresa Quadrangle. *In preparation.*
- Geology of the Long Lake Quadrangle. *In preparation.*
- Berkey, C. P. Geology of the Highlands of the Hudson. *In preparation.*
- Economic geology. Eg1 (3) Smock, J. C. Building Stone in the State of New York. 152p. Mar. 1888. *Out of print.*
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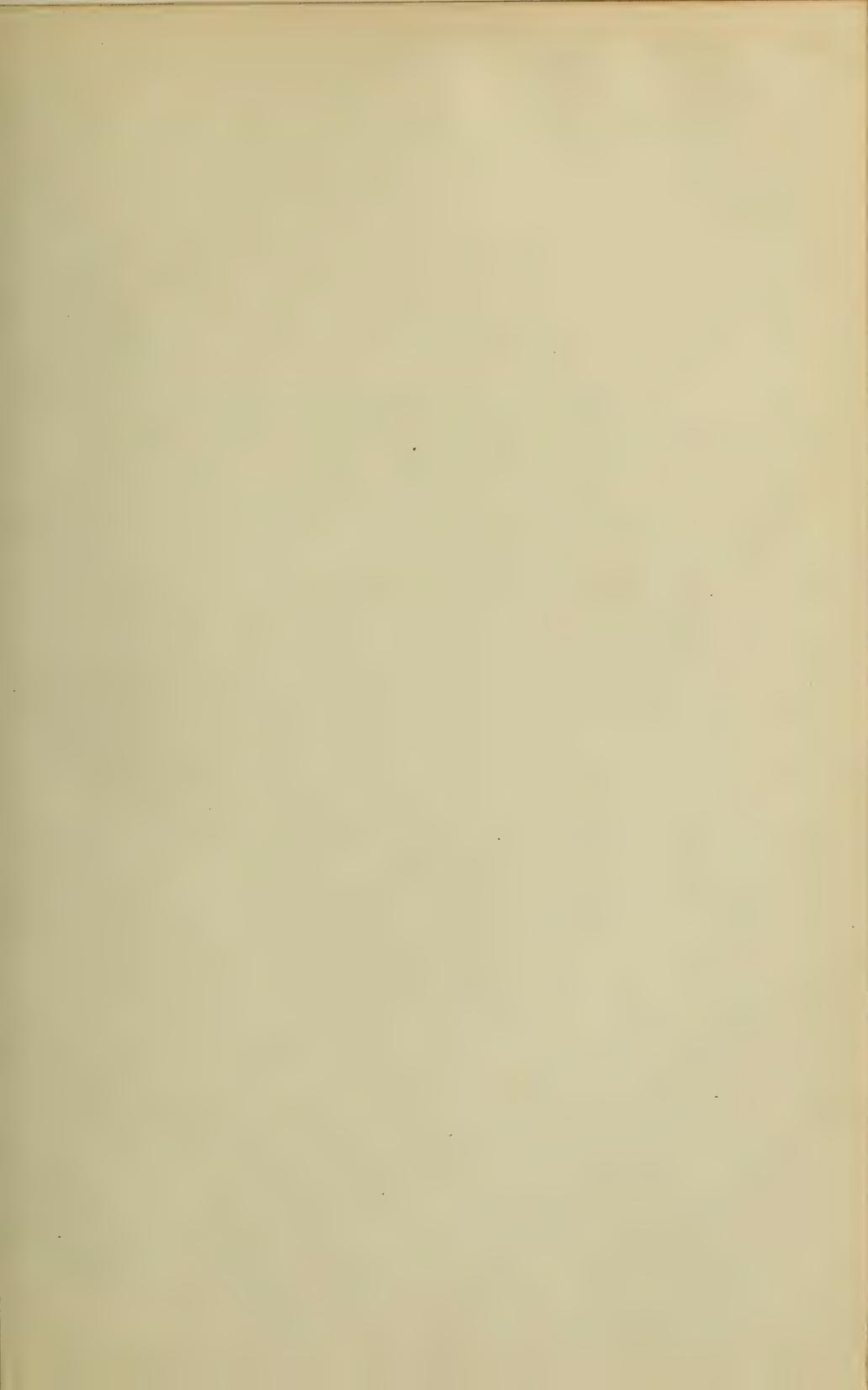
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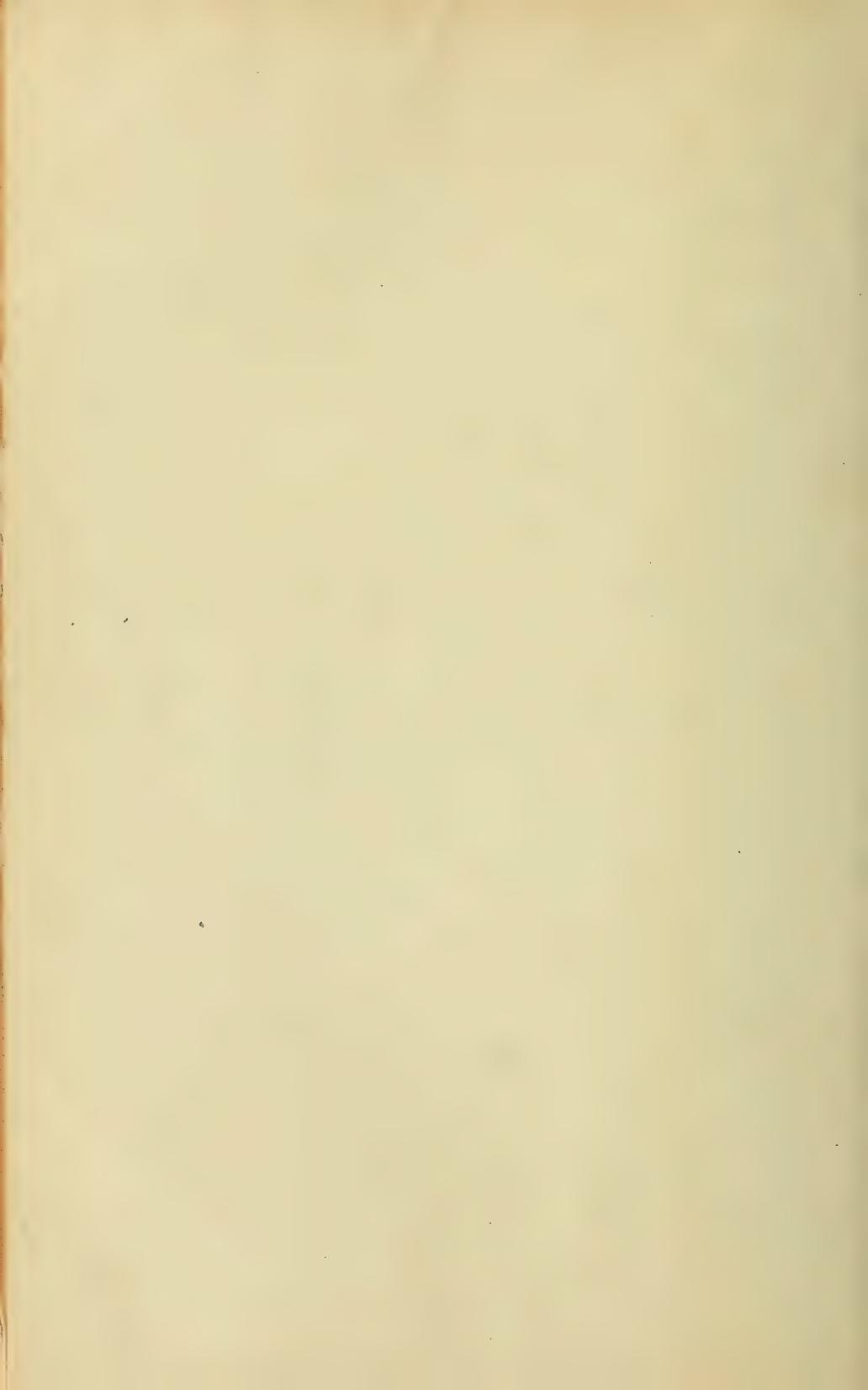
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