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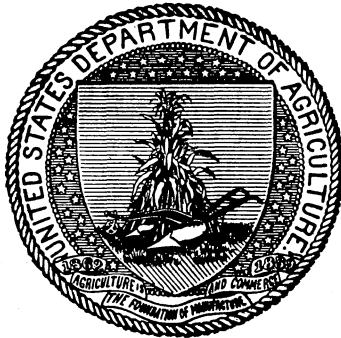
FARMERS' BULLETIN No. 453.

DANGER OF GENERAL SPREAD OF THE GIPSY
AND BROWN-TAIL MOTHS THROUGH
IMPORTED NURSERY STOCK.

BY

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY,
Washington, D. C., March 27, 1911.

SIR: I have the honor to transmit, for publication, a paper dealing with the danger of the general establishment throughout the United States of the gipsy moth and the brown-tail moth, which have been during the preceding two years, and are again the present year, imported from European countries on nursery stock and widely distributed in the United States. While every effort has been made to examine and disinfect such imported stock, it is by no means certain that all of the infested shipments have been reported and examined by inspectors, especially as, in the absence of any law, all reports and work of this kind are more or less voluntary. There is, therefore, considerable danger that the brown-tail moth, or perhaps the gipsy moth, has already become established in one or more interior points.

This paper gives a record of the infested importations during the last two years and descriptions of nursery conditions in Europe, showing the nature of the infestation there, and concludes with a brief description, with illustrations, of the two moth pests which are now being thus imported. The publication is, therefore, a warning to users of such imported stock and gives descriptions and figures enabling the prompt recognition of either of these pests wherever they may become established.

The nonexistence of a general law providing for the reporting of all imported stock and for uniform and thorough inspection and disinfection of such stock makes it highly desirable that the information here given should be made promptly available and widely distributed.

I recommend its publication as a Farmer's Bulletin.

Respectfully,

L. O. HOWARD,
Entomologist and Chief of Bureau

Hon. JAMES WILSON,
Secretary of Agriculture.

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DANGER OF GENERAL SPREAD OF THE GIPSY AND BROWN-TAIL MOTHS THROUGH IMPORTED NURSERY STOCK.

INTRODUCTION.

Winter nests of the brown-tail moth, each filled with hundreds of young larvæ, and occasional egg masses of the gipsy moth have been brought into the United States, the former in enormous numbers, during 1909-10 on imported nursery stock, and the importations for the season of 1911 are again bringing in these brown-tail moth nests. This infested stock, coming largely from nurseries in northern France, has been scattered widely over the United States east of the Rocky Mountains, and while every effort has been made to trace these importations and inspect and disinfect them the probability of many unreported shipments or inefficient inspection is very great.

A general warning is therefore given to all users of such imported plant stock, namely, to nurserymen, fruit raisers, and purchasers of ornamentals for city or park planting, to keep all such imported stock under strict watch to see that these pests do not develop.

As an aid in this direction this bulletin has been prepared. It gives a record of the infested importations of the past two years, a review of the nursery conditions in Europe showing the nature of contamination there, and a brief description, with illustrations, of the two moth pests which are now being imported and widely distributed.

IMPORTATIONS OF INFESTED NURSERY STOCK OF 1909-1911.

Space will not be taken to give the details of the shipment and distribution of infested nursery stock during these years. Some idea of the situation can be gained, however, from the following brief summary of importations, drawn largely from the annual reports of the Bureau of Entomology by Dr. Howard for the two years in question.

BROWN-TAIL MOTH NESTS IMPORTED IN 1909.

Early in 1909 it was discovered that nests of the brown-tail moth, filled with hundreds of small hibernating larvæ, were being introduced into this country on imported European nursery stock—chiefly from

northern France—and distributed into many States. These brown-tail moth nests were first reported in connection with a consignment of seedlings shipped from Angers, France, to New York. The nests were discovered by the New York State inspector, and the information was communicated to the Bureau of Entomology by the commissioner of agriculture of that State.

A little later information came from Ohio that the winter nests of the brown-tail moth had been found on seedlings imported into that State from the same locality in France.

Warning letters were promptly sent out by Dr. L. O. Howard, chief of the Bureau of Entomology, to the different entomologists, and special arrangements were made with the customs office, through the kindness of the Secretary of the Treasury, and by agreement with the railroads, so that this bureau was to be informed of all cases of plants received at customs or subsequently handled by the principal railroad companies. By this means the receipt and ultimate destination was ascertained of much of the imported stock of that year. This information was transmitted to the State inspectors and other competent persons near the points of ultimate destination of such packages and an effort was made to have all such imported material inspected.

Information was secured concerning nearly 800 shipments, divided among 35 different States. In shipments to 15 of these States, namely, Alabama, Georgia, Illinois, Iowa, Kansas, Kentucky, Maryland, Massachusetts, Missouri, Nebraska, New Jersey, New York, North Carolina, Ohio, and Pennsylvania, nests of the brown-tail moth were found, ranging in number from one nest to many nests in each shipment. These brown-tail nests—little webbed packets of leaves containing the very small hibernating larvæ to the number of 300 or 400 in each nest—were found on the seedling and other nursery stock in enormous numbers, some 7,000 nests (approximately 2,800,000 larvæ) being found in shipments to New York State alone.

In one locality in Ohio an egg mass of the gipsy moth was found and Prof. P. J. Parrott, of the New York Experiment Station, at Geneva, N. Y., found another important European fruit pest (*Hypomenota padella*), which had probably been introduced on these same French seedlings.

BROWN-TAIL MOTH NESTS IMPORTED IN 1910.

In view of the dangerous conditions of the shipments of 1909, a strong effort was made on the part of Dr. Howard to have the French authorities provide for the competent inspection and disinfection of material preliminary to the shipping season of 1910. In spite of promises of the authorities that such inspection would be made, the shipments of nursery stock from France in 1910 again brought to this country enormous quantities of nests of the brown-tail moth,

filled with the one-fourth grown larvæ. Moreover, one shipment of nursery stock from Belgium to Louisiana contained an egg mass of the gipsy moth.

All of this imported European stock was again followed up as far as possible in accordance with the arrangement of the previous year with the customs officers and by agreement with the railroads, and all reported shipments were inspected at their destination.

Of the shipments of 1910 not less than 291 different lots were found to be infested with nests of the brown-tail moth. These went to the following States: Colorado, Connecticut, Georgia, Illinois, Indiana, Kansas, Louisiana, Michigan, Montana, New Jersey, New York, Ohio, and Virginia.

BROWN-TAIL MOTH NESTS IMPORTED IN 1911.

As a result of a thorough investigation of European conditions, which will be described later, a much better effort during the last year has been made, notably in France and Belgium, to improve the conditions of export stock, and as a result the importations of the present season of 1911 so far have shown a very notable improvement in amount of infestation. Nevertheless, the imported stock still shows occasional infestation, and such infested stock is being widely distributed. The danger as the infestation becomes less general is perhaps just as great or even greater from the very natural lessening of care or greater haste which will be given to examinations, and one overlooked nest or egg mass is quite sufficient to establish these pests.

RECORDS OF DISTRIBUTION OF THE IMPORTED NURSERY STOCK INCOMPLETE.

Nursery stock imported by dealers and sent direct in bond to destination is probably all reported and subsequently examined. Much of the imported nursery stock is, however, handled by customs brokers or receiving agents in New York, and the different packing cases are so marked that these distributing agents know where to send them, and they are distributed widely over the country, often in bond, without being examined in New York, and often without any record being made of such shipment or final destination. As pointed out by Dr. Howard in his testimony before the House Committee on Agriculture, much of such nursery stock which enters at the port of New York and is thence distributed in original packages the Government has been able to trace through the courtesy of the railroads, in addition to the regular arrangement with the customs office to advise the Department of Agriculture on the receipt of such stock. Nevertheless, the information gained from the customs office is evidently incomplete, as very often the railroad companies report the handling of stock of which no advice has been gained by the customs

office, and, on the other hand, material is reported by the customs office which is not reported by the railroad companies. For this reason there is no certainty that all of the imported stock is reported, and undoubtedly some of it is miscellaneously distributed and never is examined at all. This condition of affairs, from local experience in his State, was strongly brought out by Dr. J. B. Smith, entomologist of New Jersey, in his testimony before the House Committee on Agriculture.

Dr. Smith also called attention to two other features of the importation of nursery stock which have an important bearing on the entrance of such pests as the gipsy moth and the brown-tail moth. The first of these relates to the importation by large department stores of New York, Philadelphia, and Washington, and in large interior towns, of inferior stock of ornamental plants, roses, and even fruit trees, massed down under enormous pressure in large boxes, thousands of plants in a single case. This largely worthless and often infested stock is distributed by these agencies at a very low price, or is given to the customers, and goes in small parcels here and there where it can not be followed, and necessarily entails the greatest risk of the introduction of dangerous pests and plant diseases. It is almost impossible to make any proper examination of such material even when its importation and destination are reported. Some of these shipments contain hundreds of thousands of plants, so that the chances of overlooking infestation are exceedingly great.

The other condition referred to by Dr. Smith is the importation by private persons, owners of large estates, or head gardeners, of greater or less quantities of ornamental and floral stock, such miscellaneous importations being very difficult to get advice of, and undoubtedly many of them are never reported or inspected.

CONDITIONS IN THE DISTRICT OF COLUMBIA.

A recent and very undesirable development in the introduction of foreign nursery stock has come to light in Washington, D. C., and probably is occurring in other large cities. In the latter part of March it was learned that a large shipment of miscellaneous ornamental stock had been made by a Dutch nursery firm to a local auctioneer, to be sold under the hammer, and, on the authority of the auctioneer in question, without previous arrangement. This new development seems to have arisen from an experience of the previous year (1910), where a shipment of stock was refused by the consignee and was turned over to this same auctioneer for sale. The results were evidently sufficiently satisfactory to lead the Holland firm to make the shipment of stock this year direct to the auctioneer, on the chance of a profitable sale.

The situation in the District of Columbia is probably the worst in the United States, inasmuch as there is no law whatever which authorizes the examination or inspection of nursery stock imported into the District. Examination of stock imported by local department stores, by nurserymen, and that sent for auction, as noted above, can be made only by officials of the Department of Agriculture through the courtesy of these different receivers of such stock. Very often such courtesy is scant, or refusal is made to open up the stock or separate it so that it can be properly examined. Such stock, when reported, has, however, been as thoroughly inspected as conditions permitted. It is sold to a multitude of purchasers, many of whom reside in near-by points in Virginia and Maryland, and thus finds entry into these States without the knowledge of the State officials.

NATURE OF INSPECTION AND LIKELIHOOD OF LOCAL INFESTATION.

As already indicated, the principal function of the Bureau of Entomology has been to get as complete information of importations as possible and transmit this information to the State inspectors, where such existed, of the several States. In some instances, where no local means of inspection was available, the imported material was inspected directly by agents of this bureau. In most of the States receiving infested goods the inspection made was conscientious and thorough. In some instances, however, the inspection was undoubtedly indifferent or worthless. This is illustrated by the fact that material received by a large Missouri nurseryman, and on his own statement "carefully inspected," was reshipped by him to Maryland, still infested with the brown-tail moth.

The condition of the imported nursery stock is such as to make inspection difficult and also to render it practically impossible to be absolutely sure that the inspection has resulted in the detection and destruction of all larvæ. The nests themselves are sufficiently prominent to be easily seen if the masses of thousands of plants in a case are properly separated so that each can be given individual examination. This means, however, a lot of time and absolute conscientiousness on the part of the inspector.

Many of the nests, however, in the process of packing and unpacking become broken and the minute larvæ are scattered more or less through the seedling stock and also in the packing material. Under these conditions, the chance of larvæ being overlooked by the inspector is very great. It by no means follows, therefore, that even where material is located and inspected the brown-tail moth and perhaps other pests have not been introduced. Furthermore,

the unpacking is done, in many nurseries, in the open, in close proximity to growing nursery or ornamental stock, and the packing straw and wrappings are piled about and touching growing or heeled-in trees, so that plenty of opportunity may exist for the moth larvæ, in such packing material or otherwise scattered, to find lodgment and opportunity for development.

There is also, in addition to the difficulties experienced in actual inspection, the very large risk, already indicated, that many shipments are not inspected at all.

The fact that the brown-tail moth or any other pest does not develop immediately in the regions where these infested shipments are opened is no indication that such pests have not been introduced and that they will not eventually become established. When in very scanty numbers, they are inconspicuous enough to be easily overlooked for a number of years, as was illustrated in the case of the gipsy moth near Boston, which remained slowly increasing for over 20 years before it came to public notice. The brown-tail moth, brought in on roses, probably from Holland, about 1890, also had become thoroughly established over quite a large area before it was recognized, in 1897, as a new pest. The latter case is all the more instructive because the brown-tail moth was developing in the very region which was then being thoroughly examined every year for the gipsy moth. It may well be possible, therefore, that either the brown-tail moth or the gipsy moth is now slowly gaining headway at different points in one or more States as a result of the shipments of infested material of 1909 and 1910.

SIGNIFICANCE OF IMPORTATIONS OF 1909-1911.

It is scarcely necessary to comment on the tremendous danger which the importations of nursery stock of the last three seasons have brought to this country. The enormous cost of the gipsy moth and the brown-tail moth in New England is now well known. Throughout the infested districts of New England orchards have been completely destroyed and forests largely obliterated, and even where woodlands and parks have been protected at an enormous expense their beauty and value have been vastly lessened.

Massachusetts has spent millions of dollars in an effort to control these pests, and with their spread to other States the work of control has been taken up in these also. The National Government has been asked to come to the rescue, and is now appropriating \$300,000 a year in the mere attempt to check the distribution of these pests along the principal highways. Massachusetts and the other infested New England States are now spending more than a million dollars a year in control work. In spite of these efforts

and this enormous expenditure the gipsy moth and the brown-tail moth are steadily spreading in New England and great damage is experienced from them yearly. Extermination is entirely out of the question, and all these expenditures must go on indefinitely at a probably increasing rate, unless some natural check by means of parasites can be brought about.

In addition to the great destructiveness of these pests to orchards and forests, their establishment in any suburban residential district means an enormous depreciation in property values, as is now illustrated about the city of Boston, and very notably lessens the attractiveness of coast or mountain summer resorts. The north shore towns of Massachusetts and lower Maine resorts have already felt this influence, and for such regions as the Catskills or Adirondacks the establishment of these pests would be most disastrous, inasmuch as control over such extended forested mountains is practically impossible.

When it is realized that these two pests have been widely distributed, on imported nursery stock, in 22 States during the years of 1909 and 1910, and are now coming in on imported stock from France and Belgium, the danger to the whole country is fully apparent, and this danger applies to every orchard and to every owner of private grounds and also to our entire forest domain. The tax from these pests, should they gain foothold throughout the country, as measured by the existing cost in New England, is almost beyond estimate.

EFFECT OF THE BROWN-TAIL MOTH ON HEALTH.

In addition to the great monetary loss, the brown-tail moth exercises a very deleterious effect on health. The hairs which cover the caterpillars of this moth are strongly nettling, and not only are they so from accidental contact with a caterpillar which may fall on clothes, face, neck, or hands from an infested tree, but also from the myriads of hairs which are shed by these caterpillars when they transform to the chrysalis state. The latter fall and find lodgment on clothing, or collect on the face, neck, or hands, and frequently cause very disagreeable and extensive nettling, the effects of which may last for months. Breathed into the lungs they may cause inflammation and become productive of tuberculosis. The brown-tail rash is well known throughout the regions infested in New England and thousands have suffered from it. All of the assistants who have been connected with the Government work with these pests in the New England States have been seriously poisoned. Two of them have had to give up their work and go to the Southwest to attempt to recover from pulmonary troubles superinduced by the irritating hairs of the brown-tail moth, and the death of one man employed on the work was due to severe internal poisoning contracted in field work against larvæ.

This insect is, therefore, a most undesirable neighbor, even if it were not responsible for great injury to orchards and ornamental trees.

CHARACTER AND VALUE OF IMPORTED NURSERY STOCK.

The actual value of the importations of nursery stock which is thus jeopardizing the entire fruit and forest interests of this country, as declared at customs during the years 1907 and 1908, of which we have tabulated records, is about \$350,000 annually, but little more than the sum which the United States Government is spending every year in an endeavor to eliminate the spread of the gipsy moth and the brown-tail moth, and one-third the sum which the New England States are spending annually in an attempt to control these pests.

The major part of the imported stock consists of seedling apple, pear, plum, and cherry from north France. There is also considerable importation of ornamental and flowering plants, shrubs, and trees. The latter is purely commercial, and comes in very largely for the reason that it can be produced more cheaply abroad than in this country. Of the seedling stock, it is claimed by nurserymen that the imported plum, cherry, and quince stock particularly is much better material for grafting purposes than home-grown seedlings. In the case of the apple seedlings, however, the great mass of such stock is still produced in this country and can undoubtedly be just as well produced here, if not better, than in France or elsewhere in Europe.

The stock of the last two years which has been most infested has come from northern France, accumulated from various smaller or larger nurseries, including a French seedling agency, managed by an American corporation composed largely of New York nurserymen.

If, as is claimed, some of this seedling stock is better than any that can be produced in this country, it becomes all the more imperative that such stock, or all imported stock, should be subject to rigid inspection, and that every possible means should be taken to safeguard this country from the further establishment of these two very dangerous insect pests.

EUROPEAN NURSERY CONDITIONS.

During the summer of 1909, and also again in 1910, Dr. Howard, who was in Europe principally to supervise the introduction of parasites for the gipsy and brown-tail moths into Massachusetts, made a careful inspection of the nursery regions of Holland, Belgium, and northern France, and also England.

The writer was in Europe, on a personal trip, in the summer of 1909, and made an examination of similar conditions in Holland, Belgium, and parts of Germany.

Holland probably presents the cleanest bill of health in the matter of insect pests, and particularly of the gipsy moth and brown-tail moth. This country enjoys a good inspection service, and all Dutch nurseries are carefully inspected twice each year, so there is probably less danger now from shipments from Holland than from any other country.

Belgium, in 1909, was in very bad condition, and the writer found the brown-tail moth more abundant there than he had ever seen it, hedge rows often being plastered with the winter nests. One such row the writer noted was only a few miles from the border of Holland and within easy flight of the moths to large Dutch nurseries. Belgium has, however, since September, 1909, established an inspection service, applying only to nurseries exporting to America and limited to field examination, twice yearly, of growing stock. While a distinct improvement, the inspection as indicated is still inadequate, as shown by much infested stock still coming to this country under official certificate.

In France, in 1909, Dr. Howard found no governmental inspection system of nurseries. The certificates attached to shipments of nursery stock received in this country from France were signed, as a rule, by men connected with agricultural schools, and probably in the case of most of the certificates the stock had never been seen by the expert. The general infestation of the stock coming from France to this country during the last two years made it abundantly plain that these certificates were absolutely valueless.

Dr. Howard found that nursery stock for export was in many cases grown in the vicinity of hedges and trees infested with the brown-tail moth and gipsy moth and other injurious insects not yet introduced into the United States, and no special precautions were being taken by the nurserymen to prevent the infestation of export stock by injurious insects. The brown-tail moth nests are so characteristic and noticeable that it is only by absolute indifference on the part of French exporters that they are packed for shipment without removal.

As a result of the agitation of 1909, the French exporters promised to take all possible precautions, and the French ministry of agriculture promised to found a governmental inspection service. The Chamber of Deputies, however, failed to pass the inspection law proposed by the ministry of agriculture, and, as already noted, the condition of the "inspected material" of 1910 was no better than in the previous year.

The director of agriculture of France, however, continued to urge the need of a plant-inspection service for export nursery stock, and early in November of 1910 this department was advised, through the Department of State and the ambassador of France to the United

States, of the final establishment of such service. Later the details of the law were communicated to Dr. Howard by Dr. Paul Marchal, who is charged with its execution.

Dr. Marchal's high reputation gives a guarantee of thoroughness, and a great improvement has actually taken place in the condition of the nursery stock coming from France. The rank infestation of 1909-10 has given place to moderate infestation of 1911, but there is still decided room for betterment.

In England Dr. Howard found that, as in France, there was no governmental nursery inspection. The nursery conditions there are somewhat better than in France, but the brown-tail moth and other injurious insects which might easily be imported on nursery stock occur in England. The officials of the Government had the establishment of a governmental inspection service under consideration, and were willing to establish such a service, but stated that the demand for it must come from British nurserymen. An attempt was therefore made by Dr. Howard to get these interests to ask for such service, and, while no action has yet been taken, it seems probable that the English Government will move in this direction.

IMPORTATION OF REFUSE STOCK.

The fact that all the continental countries of Europe have enacted very strict inspection and quarantine laws relating to the entrance into their territories of nursery stock, or other living plant materials, operates very unfavorably for this country, where there is no bar to the entrance of any stock, however worthless, or insect-infested, or diseased. As a result, the United States receives, in addition to fairly good nursery stock brought in by reliable importers, a great mass of refuse stock, imported under the worst conditions, massed in vast quantities in large packing cases, at best in poor condition and often diseased or insect-infested. The United States thus becomes a sort of dumping ground for material which could not find sale in Europe. Much of this worst-quality stock is that referred to elsewhere as being imported by department stores of our larger cities, and also by unscrupulous nurserymen who are careless of their own reputations and the interests of their customers.

NECESSITY OF QUARANTINE LEGISLATION.

The necessity of National quarantine to prevent the general introduction of such dangerous insect pests as those discussed in this bulletin, and also of equally dangerous plant diseases, has long been recognized.

The need of legislation is much increased by the fact that the United States is the only great power without protection from the

importation of insect-infested or diseased plant stock. Referring to European powers only, Austria-Hungary, France, Germany, Holland, Switzerland, and Turkey prohibit absolutely the entry from the United States of all nursery stock whatever. Furthermore, our fruits are admitted to these countries only when a most rigid examination shows freedom from insect infestation. Most of the other European countries have strict quarantine and inspection laws, and the same is true of important English and other colonial possessions.

A properly enforced quarantine inspection law in the past would have excluded many, if not most, of the foreign insect enemies which are now levying an enormous tax upon the products of the farms, orchards, and forests of this country. Fully 50 per cent of the insect pests in this country are of foreign origin, and new important foreign pests are becoming established practically every year.

It is of the greatest importance, therefore, that an adequate inspection and quarantine law be passed at the earliest moment.

BRIEF DESCRIPTION OF THE DIFFERENT STAGES OF THE GIPSY AND BROWN-TAIL MOTHS.

THE GIPSY MOTH.

The gipsy moth (*Porthetria dispar* L.) is an European pest which was accidentally introduced into Massachusetts nearly 40 years ago, and has since spread rather slowly, being still confined to the eastern part of Massachusetts and Rhode Island, the southern part of New Hampshire, and to more or less isolated localities in eastern Connecticut and southwestern Maine.

The presence of this insect was first discovered in Boston in 1889, and the State of Massachusetts for a number of years kept up a vigorous effort to exterminate the insect, making large appropriations therefor. This work was abandoned, however, in 1900, but the conditions soon became so bad that appropriations were again made in 1905, and have since been continued annually. In spite of the work of that State, the situation became so serious that the National Government, particularly on the ground of the great danger that these pests would soon spread to other States, was called upon to assist, and since 1907 Congress has been making annual appropriations to aid in the work of control. The amount of this appropriation is now \$300,000 annually.

The destructive work of the gipsy moth has been referred to in the foregoing portions of this bulletin. A brief sketch is here given of the life history and habits of the insect with photographs to aid anyone in promptly recognizing it should it appear in new localities.

The gipsy moth has a wide distribution throughout middle and southern Europe, northern Africa, and Asia, including Japan. In a

large portion of the Old World range of the gipsy moth it is occasionally abundant and injurious, but as a rule it is held in check by parasites and natural enemies, and in no instance have there been such continuous and disastrous depredations as those exhibited in Massachusetts and more recently in the adjacent New England States.¹

European outbreaks usually terminate in two or three years. Nevertheless in recent years in Europe and Asia exceptional outbreaks have occurred in which thousands of acres of forests have been completely denuded, and where such denudation has been repeated for two or three years in succession enormous areas have been found covered with dead and dying trees.

The following description of the different stages and habits of the insect is reproduced from Farmers' Bulletin 275 (pp. 12 to 15):

Description of the different stages of the insect.

The eggs.—The eggs of the gipsy moth are laid in masses (fig. 1) of about 500. The individual egg is minute, about the size of a pinhead, and is salmon-colored when first laid, but turns dark in the course of a few weeks. Each egg mass is yellowish in appearance and seems covered with hair. It is somewhat oval, being one-half of an inch long and about three-fourths of an inch wide. During winter, from exposure to moisture in the atmosphere, it becomes dingy white in color. Egg masses have been found on bark of imported stock during the last two years, and inspectors should be on the lookout for them.



FIG. 1.—Egg mass of the gipsy moth (*Porthetria dispar*). (From Kirkland.)

The larva, or caterpillar.—The young larvæ or young caterpillars are dark in color and well furnished with dark hairs. The full-grown larva (fig. 2) is between 2 and 3 inches long, dark brown or sooty in color, with two rows of red spots and two rows of blue spots along

the back, and with a yellowish but rather dim stripe between them. The body generally is clothed with long hairs, and sometimes reaches the length of 3 inches.

The pupa.—The pupa (fig. 3) is not inclosed within a perfect cocoon, but the full-grown larva spins a few threads of silk as a sort of support and changes to the pupa, which is dark reddish or chocolate in color and very thinly sprinkled with light reddish hairs.

The adult, or moth.—The male moth (fig. 4) is brownish yellow in color, sometimes having a greenish-brown tinge; it has a slender body, well-feathered antennæ, and a wing expanse of about an inch and a half. The forewings are marked with wavy zigzag darker lines. It flies actively all day as well as by night.

The female moth (fig. 5) is nearly white, with slender black antennæ, each of the forewings marked with three or four zigzag, transverse, dark lines, and the outer border of both pairs of wings with a series of black dots. The body of the female is so heavy as to prevent flight.

¹ For a more detailed account of the gipsy moth, see Farmers' Bulletin No. 275 (1907) and Bulletin 87 (1910), Bureau of Entomology, U. S. Department of Agriculture.

Seasonal History.

The moths emerge from the pupæ from the middle of July to the middle of August, the date varying considerably according to the season. After mating they live but a short time, and the female dies after depositing her eggs.

The eggs are laid therefore in July and August. They are deposited by the moths on the trunks of the trees upon which the caterpillars have lived, and in fact usually in the vicinity of the place where the female has transformed. The caterpillars before transforming frequently crawl for some distance from the trees upon which they have been feeding, and it therefore happens that the egg masses will be found on fences and in all sorts of protected situations in which the caterpillars hide during the day. The crevices in stone fences often contain very many of these egg masses, and knot holes in old trees will also contain many which would not at first be discovered. The egg masses are found also in hollow trees, in crevices under rough bark, on shrubbery, on buildings, in wood-piles, in barrels, in boxes, and among rubbish in dooryards. The moths seem to choose the inner or lower surface of an object upon which to lay their eggs, and therefore egg masses are placed out of sight perhaps as often as in sight.

The eggs hatch about May 1, and the young caterpillars begin immediately to feed, usually upon the lower surfaces of the leaves. As they grow they cast their skins several times, and as they become larger they feed only at night, hiding during the daytime, usually in clusters on the shady side of tree trunks, beneath large limbs, in holes in trees, under loose bark, and in fact under any near-by shelter. It is the habit of most of them to descend before daybreak upon the trunks of the trees and to seek for such shelters as those just indicated, returning after nightfall to resume their nocturnal feeding.

The larvæ usually become full grown about the 1st of July, and then transform to pupæ. The pupæ are found in the same situations as those we described for the egg clusters, but are found also in the foliage of trees and shrubs.

How the Insect Spreads.

As indicated above, the bodies of the females are so heavy as to prevent flight. Therefore the insect must be principally distributed while in the caterpillar or larval condition. The caterpillars are active crawlers, but as a rule do not migrate from the localities where they were born except when food is scarce. When young, and when there is hardly enough food, the larvæ spin down from trees by means of silken threads and often alight upon vehicles of one kind or another, and are thus carried often for great distances from the place of birth. Trolley cars, carriages, automobiles, and bicycles are thus means of transportation almost unlimited in their possibilities. The caterpillars often crawl upon vehicles which happen to stand for any length of time in an infested locality, and thus may be carried great distances. Sometimes even pedestrians aid unwittingly in this distribution, since the caterpillars may drop by their threads upon the garments of a person passing under an infested tree.

The species may be transported, too, in the egg stage on nursery or ornamental stock, as already noted, and it has been shown that the egg clusters are laid upon many different kinds of objects. Cord wood stacked and piled may be carried away in the autumn bearing many egg masses, and, if not burned before summer, larvæ may issue in a new locality. The same may be said for lumber piles near infested trees. Freight

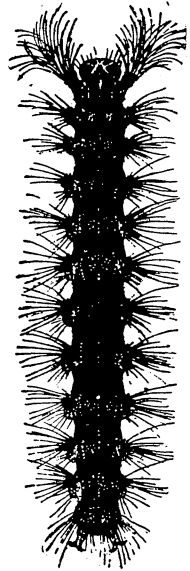


FIG. 2.—Full-grown caterpillar of the gipsy moth. Natural size. (From *Insect Life*.)

cars may have been sidetracked near an infested place long enough to permit laying of the eggs upon them.

It is by these methods that the comparatively rapid spread of the insect previously noticed, during the years 1900-1905, is to be explained.

Damage to Plants.

The larva of the gipsy moth feeds upon the foliage of practically all orchard trees, all shade and ornamental trees, all out-of-door shrubs, and all forest trees. Not only are the deciduous forest trees stripped, but the coniferous trees as well. In June and July patches of forests in the infested territory are stripped of every green leaf and the trees appear as bare as in winter. After several such consecutive strippings, deciduous forest and shade trees are killed, but with a coniferous tree, such as a pine, hemlock, or spruce, one complete stripping will cause death. It is this fact which makes the gipsy moth so much more serious a pest than the brown-tail moth, and the loss which will result from its spread into northern New England will be very great, owing to the enormous coniferous forest interests in that part of the country.

In cities and towns the insect does damage not only by destroying all vegetation, but by swarming in numbers upon and about houses, frequently entering them. It

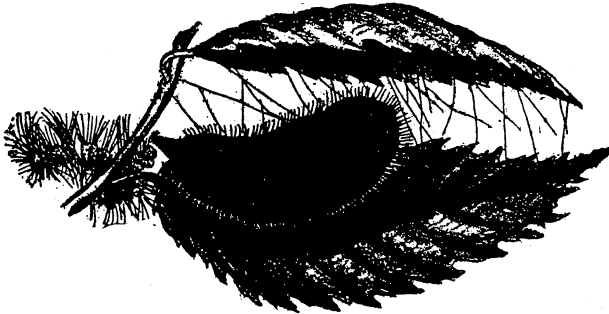


FIG. 3.—Pupa of the gipsy moth. Natural size. (From *Insect Life*.)

has been the experience in eastern Massachusetts that where a locality becomes thoroughly infested the value of real estate rapidly depreciates, and it becomes a matter of difficulty to rent or sell property.

Among its food plants the gipsy moth caterpillar seems to prefer apple, white oak, red oak, willow,

and elm, but those who have studied it most carefully in Massachusetts say that it will on occasion devour almost every useful grass, plant, flower, shrub, vine, bush, garden, or field crop that grows in the State.

THE BROWN-TAIL MOTH.

The brown-tail moth (*Euproctis chrysorrhæa* L.) was imported by a florist in Somerville, a suburb of Boston, about 20 years ago, probably on roses from Holland or France. Its presence was not discovered until 1897, when it had already gained such headway that extermination was out of the question. Since 1907 it has rapidly spread, and its range now includes much of the coastal area of New England, including eastern Rhode Island, the eastern half of Massachusetts, the eastern half of New Hampshire, and the southern half of Maine. Both sexes are strong fliers, and the prevailing winds during the flying season (July) have carried the insect northward and eastward, rather than southward and westward. Moths of this species have been taken as far away from Boston as St. Johns, New Brunswick.

This insect is a very serious enemy of orchard, forest, and shade trees and all ornamental shrubbery. In Europe it has a wide distribution, extending from England to the Himalayas, and as far north as Sweden and as far south as Algeria. It is a well-known orchard pest, and for many years laws have been operative in Europe requiring the property owners to clear their trees of the hibernating nests of this insect in winter.

The damage to trees and shrubs by this insect is often very severe. It has a special liking for pear and apple, but has a recorded list of over 80 different food plants. Thousands of fruit trees in the vicinity of Boston have been killed by this insect, and serious injury has been done to woodlands and forests, not, however, equaling the damage by the gipsy moth. It does not seem to attack coniferous trees.

One of the most serious results of the presence of the brown-tail is the poisoning of human beings by the hairs shed by the caterpillars, discussed in an earlier paragraph of this publication (p. 11).

The following description of the different stages of the insect and its seasonal history is taken from *Farmers' Bulletin 264*, which gives a general account of this pest, with general methods of controlling it.¹

Description of the Different Stages of the Insect.

The eggs.—The eggs of the brown-tail moth are small and globular, and are laid in masses on the underside of leaves in the latter part of July. The egg masses are brown in color and are covered with hair, each mass containing about 300 eggs. They are much smaller than the egg masses of the gipsy moth, with which they are most likely to be confused, and average about two-thirds of an inch in length by about one-fourth of an inch in width. They are thus elongate in form, and are convex.

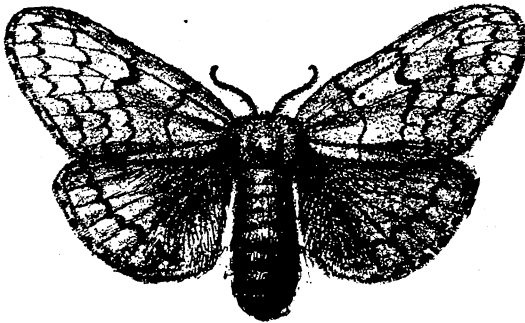


FIG. 5.—Female gipsy moth. Slightly enlarged. (From *Insect Life*.)

a broken white stripe on each side and two red dots on the back near the hind end. It carries also patches of orange and is covered with tubercles bearing long barbed hairs. The tubercles along the back and sides are covered with short brown hairs in



FIG. 4.—Male gipsy moth. Slightly enlarged. (From *Insect Life*.)

The larva, or caterpillar.—

The full-grown larva (fig. 6 at right) is about 2 inches long, reddish brown in color, with

¹ For a full account of the brown-tail moth see *Farmers' Bulletin 264* (1906) and *Bulletin 87* (1910), Bureau of Entomology, U. S. Department of Agriculture.

addition to the longer ones, which give the tubercles when magnified an appearance like velvet. The head of the larva is pale brown with darker mottlings.

The young larvæ are of a blackish color covered with reddish brown hairs. The head is jet black. Close examination will show projecting from the back of the fourth and fifth abdominal segments a large tuft of reddish brown hairs, and on the middle line of the ninth and tenth segments is an orange or reddish tubercle which may be withdrawn into the body. After the second spring molt the larva is about three-eighths of an inch long, the yellow markings on the body are more apparent, and the brown tufts on the back less prominent, while the band of white dashes along the sides, characteristic of the full-grown larva, is noticeable.

The pupa.—The full-grown larva spins a cocoon of grayish silk, which is very loose in its construction and is so far from being compact that the pupa may be readily seen through it. The pupa itself is about five-eighths of an inch long, dark brown in color, with a conical spine at the end of the abdomen bearing a cluster of minute hooks at the tip. Smooth, yellowish brown hairs are found scattered over the abdomen and the top of the thorax.

The cocoons are apparently spun by preference among the leaves at the tips of

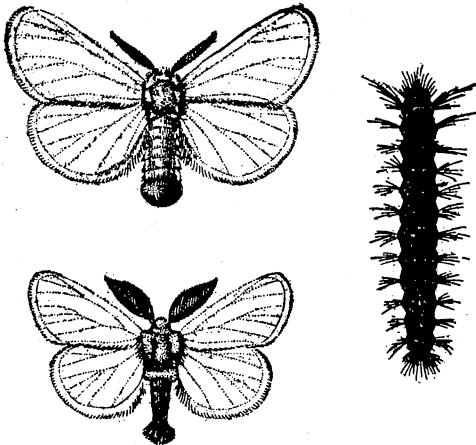


FIG. 6.—The brown-tail moth (*Euproctis chrysorrhœa*): Female moth above, male moth below, larva or caterpillar at right. Slightly enlarged. (From Howard.)

branches, and often a dozen or more larvæ will spin a common web within which each individual forms its own cocoon and transforms to pupa. The cocoons are also found under fences and beneath the edges of clapboards. Mr. Kirkland has seen a mass of cocoons nearly 2 feet across in the cornice of a house in Somerville.

The adult, or moth.—The moths (fig. 6, at left) are pure white, the end of the abdomen being brownish, and both sexes bear at the tip of the abdomen, more conspicuously with the female, a tuft of brown hairs, almost globular in form, from which comes the name brown-tail moth. It is the only moth occurring in America to which this description applies, and is therefore

unmistakable. The female expands about $1\frac{1}{2}$ inches, and the male is smaller.

Seasonal History.

The moths fly in New England from the 1st to the 20th of July, the time varying with the condition of the season. In 1898 the height of the flying season is said by Fernald and Kirkland to have been July 16, in 1899 July 8, and in 1902 July 14. It is a night-flying insect, and only a few are ever seen on the wing in the daytime. Soon after sunset a few begin to fly, the number increasing as it grows dark, and from 10 o'clock to midnight they swarm to the greatest extent. They are strong flyers, and are attracted to light. So great have been their numbers in the infested region that the sides of red brick buildings near electric lights have appeared perfectly white. It is at this time that the great spread of the species occurs, and the reason that the direction of the spread has been greatest toward the northeast has been the fact that the prevalent night winds at that time of the year seem to have been from the southwest. Aside from actual flight, the species has spread by being carried in the moth condition on railway trains and on vessels. Captains of vessels have reported

that the moths have alighted upon their ships in great numbers in the vicinity of Boston along toward midnight on several occasions, and the introduction of the species at more than one seaport in Maine has been by means of vessels coming from the infested district rather than by direct flight. Of course, the brown-tail moth is carried in the caterpillar stage, just as is the gipsy moth, upon vehicles of different kinds passing through the infested region and upon the persons of pedestrians as well. In late May, 1906, the writer, in company with three other persons, walked through the woods in a region not far from Boston, and although the most careful efforts were made by each of us to pick the caterpillars from the clothes of the others, an hour or two afterwards, and many miles away by automobile, still others were found under the upturned trousers and lapels of coats and in other hidden places about garments.

The eggs are laid by the moths soon after the flight begins, say in the latter part of July. They hatch during August and the young larvæ feed in clusters on the upper surface of leaves, skeletonizing them and causing the foliage to turn brown as if blighted. At first they feed upon the leaf which bears the egg mass, but soon wander to others, returning at night to the original leaf. When first hatched they are about one-twelfth of an inch long, and in five to six days shed their skin, increasing in length to one-fifth of an inch.

Later the second molt occurs, although this sometimes does not take place until autumn within the winter web. Along in September they begin to spin their winter webs by drawing together a number of leaves with silk, and in each of these nests a large number of caterpillars stow themselves away for the winter. These webs or nests, composed of leaves and silk, will average from 5 to 6 inches in length, and each will contain 200 or more caterpillars. The caterpillars feed until cold weather, and then all enter the web and close the exit holes. They are then about one-fourth grown.

These winter webs (fig. 7) of the brown-tail moth are very characteristic, and there are practically no other insect structures common upon trees which may be mistaken for them. There are certain old webs of native species which might possibly, by the untrained eye, be considered to be those of the brown-tail moth, but these are empty in the winter time. Any web of this character and general size found during the winter which contains young caterpillars in any number is the web of the brown-tail moth.

The following spring, as soon as the buds begin to appear upon fruit trees, these young, one-fourth-grown caterpillars issue from the overwintering nests and attack first the buds and blossoms and later the foliage. Apparently half starved by their long hibernation, they come out with voracious appetites, and the amount of damage done by them at this time is extraordinary. Old trees may lose all their buds, or, if the leaf buds and blossom buds burst, the foliage itself may be entirely destroyed at a later date. The growth of the larva is rapid, and it reaches full size and begins to spin its cocoon during the last half of June, transforming to pupa and remaining in this condition for approximately 20 days.



FIG. 7.—Winter nest of the brown-tail moth, containing 300 or 400 young caterpillars. (Original.)

Damage to Plants.

As just indicated, the damage to trees and shrubs may be very severe. The list of food plants is very extensive. While there seemed at first to be a preference for pear and apple, the larvæ were found to feed also upon the stone fruits, as well as upon the elm, maple, and several species of oak. Of late years there has been a very extensive infestation of scrub oak and of the larger trees of the genus *Quercus*. In fact, the caterpillars feed generally upon all deciduous trees, on many shrubs, and even upon herbage. A list of over 80 different food plants was published by Fernald and Kirkland in 1903. Thousands of fruit trees in the vicinity of Boston have been killed by this insect. Injury to woodlands and forests has not been as severe as that accomplished by the gipsy moth, and coniferous trees do not seem to be attacked, but the damage to oak, maple, and elm in the wooded region has been sufficient to cause the forests to appear brown in June in places, and complete defoliation for a series of three or four years has brought about the death of many trees. Even where the tree survives, its growth has been checked, and there is a timber loss.